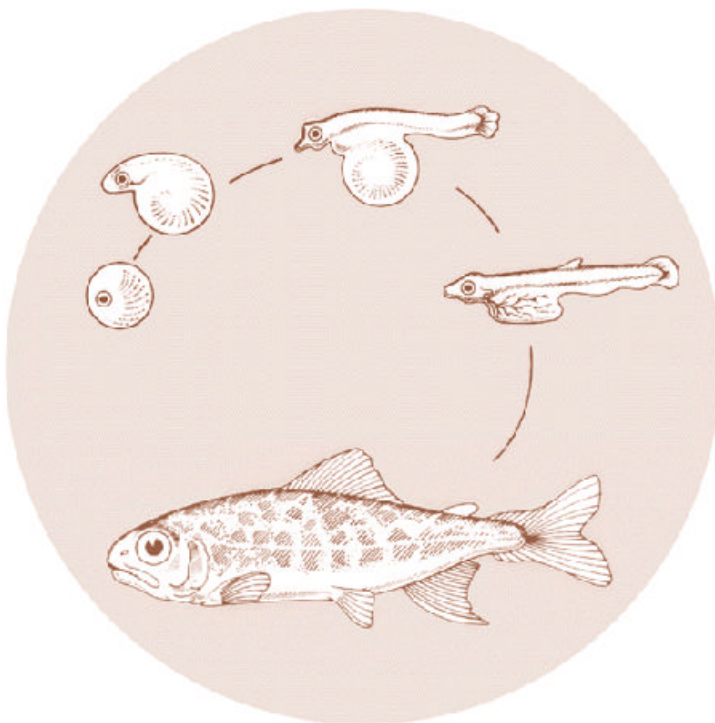


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UMATILLA HATCHERY MONITORING AND EVALUATION

November 1, 1996 - October 31, 1997

Annual Report 1997



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UMATILLA HATCHERY MONITORING AND EVALUATION

ANNUAL REPORT 1997
(NOVEMBER 1, 1996 - OCTOBER 31, 1997)

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EXECUTIVE SUMMARY

This report summarizes monitoring and evaluation studies of salmonids reared at Umatilla Hatchery for the period November 1, 1996 to October 31, 1997. Studies at Umatilla Hatchery are designed to evaluate rearing of chinook salmon and steelhead in "Michigan raceways". Characteristics of Michigan raceways include high fish densities, rapid water turnover, oxygen supplementation, reuse of water, and baffles designed to reduce cleaning. Fish health at Umatilla Hatchery and other facilities associated with the Umatilla program are intensively monitored and evaluated as part of the overall research project. Further, under the Integrated Hatchery Operations Team guidelines, specific requirements for fish health monitoring are mandatory and have become the responsibility of the fish health staff conducting the studies at Umatilla Hatchery. Additional studies include evaluations of sport fisheries in the Umatilla River and mass marking and straying of fall chinook salmon. Except for adult recovery data, an experiment designed to evaluate rearing subyearling fall chinook salmon in Michigan and Oregon raceways has been completed. We are currently in our first year of rearing subyearling fall chinook salmon at three densities. Experimental rearing of subyearling, fall release, and yearling spring chinook salmon and steelhead has also been conducted. Although preliminary adult return data has been recovered, data on post-release survival for all groups is incomplete. Conclusions in this report should be viewed as preliminary and used in conjunction with additional data as it becomes available.

Objectives for Fiscal Year 1997

Hatchery Monitoring and Evaluation

1. Document egg-take, egg-to-fry and egg-to-smolt survival for salmon and steelhead reared at Umatilla and Bonneville hatcheries and released in the Umatilla River.
2. Document rearing densities, loading, and cost of salmon and steelhead reared at Umatilla, Bonneville, Carson, Little White Salmon, and Willard hatcheries and released in the Umatilla River.
3. Document number, size, time, and release location for salmon and steelhead reared at Umatilla, Bonneville, Carson, Little White Salmon, and Willard hatcheries and released in the Umatilla River.
4. Monitor water quality in Michigan and Oregon index raceways containing salmon and steelhead.
5. Collect and compare monthly length, weight, and condition factor estimates for salmon or steelhead reared in Michigan and Oregon raceways at Umatilla Hatchery.
6. Calculate growth for salmon and steelhead reared in Michigan or Oregon raceways at Umatilla Hatchery.

7. Determine fin condition, descaling, smolting, length, weight, and condition at pre-release or release for salmon and steelhead reared at Umatilla and Bonneville hatcheries and released in the Umatilla River.
8. Compare the physiological stress response of fall chinook salmon reared at three densities in Michigan raceways at Umatilla Hatchery.
9. Evaluate smolt migration performance of paint-marked salmon or steelhead reared at Umatilla, Bonneville, Carson, Little White Salmon, and Willard hatcheries, released in the Umatilla River and recovered at John Day dam.
10. Evaluate smolt-to-adult survival of salmon and steelhead by fin marking, coded-wire-tag or blank-wire-tagging.
11. Summarize catch and escapement data from coded-wire-tagged salmon and steelhead released in the Umatilla River.
12. Evaluate straying of adult fall chinook salmon from releases in the Umatilla River.
13. Evaluate and compare the effects of tagging and marking on smolt-to-adult survival of subyearling fall chinook salmon.
14. Estimate the sport harvest of salmon and steelhead in the Umatilla River with statistical creel methods.
15. Participate in the development of water quality sampling and monitoring in the Umatilla River basin.
16. Participate in production and management planning activities for anadromous fish in the Umatilla River basin.

Fish Health Monitoring and Evaluation

1. Conduct monthly fish health examinations on five fresh-morbid or moribund juvenile fish from index raceways of each species and stock reared at Umatilla Hatchery.
2. Conduct monthly fish health examinations on five grab-sampled juvenile fish from the lower raceway of each chinook salmon series at Umatilla Hatchery.
3. Conduct preliberation fish health examinations on 30 grab-sampled yearling chinook salmon per evaluation raceway at Umatilla Hatchery four weeks prior to release.
4. Conduct preliberation fish health examinations on ten grab-sampled yearling steelhead per raceway at Umatilla Hatchery four weeks prior to release.
5. Develop disease profiles of fish reared under differing conditions and make comparisons between

rearing strategies.

6. Examine fish when unusual loss or behavior occurs using appropriate diagnostic methods. Implement therapeutic or prophylactic measures to control, moderate, or prevent disease outbreaks.
7. Continue implementation of Federal Drug Administration Investigational New Animal Drug protocols, including prophylactic feeding of aquamycin to spring chinook salmon juveniles at Umatilla Hatchery.
8. Continue implementation of prophylactic and therapeutic treatments, either under Federal Drug Administration Investigational New Animal Drug protocols or prescriptions for oxytetracycline, erythromycin, formalin, and chloramine-T, as needed for disease treatments of all species, ages, and stocks at Umatilla Hatchery, Minthorn Ponds, South Fork Walla Walla Adult Facility, and Three Mile Dam Adult Facility.
9. Examine fish at Thornhollow and Imeqes C-mem-ini-kem acclimation facilities during periods of unusual loss or for preliberation following transfer from Umatilla Hatchery, Little White Salmon National Fish Hatchery, and Willard National Fish Hatchery.
10. Collect *Renibacterium salmoninarum* and culturable virus data from up to twenty spawned females, per spawning date, per species providing eggs for Umatilla Hatchery.
11. Analyze data from broodstock sampling to anticipate potential disease problems in progeny and develop subsequent control recommendations or possible treatments.
12. Continue to develop expertise in statistical analysis pertinent to the epidemiological evaluations at Umatilla Hatchery. Use this to analyze trends in all data accumulated to date.
13. Monitor coded-wire tag spring chinook salmon adults, reared at Umatilla and Bonneville Hatcheries and returned to the Umatilla River, for *Renibacterium salmoninarum*.

Accomplishments and Findings for Fiscal Year 1997

Hatchery Monitoring and Evaluation

Except for testing the physiological stress response of subyearling fall chinook salmon, we achieved all of our objectives in fiscal year 1997. We initiated a study to evaluate the success of rearing subyearling fall chinook salmon at three densities in Michigan raceways. This study will be replicated for a minimum of four years.

Fall Chinook Salmon

Subyearlings, Rearing in Michigan and Oregon Raceways: Estimates of smolt-to-adult survival from the 1991 brood were inconclusive because few adults were recovered. Total smolt-to-adult survival for the 1992 brood (through age four) averaged 0.03%. Preliminary data suggests similar survival rates for fish reared in Michigan and Oregon raceways and among groups reared in first, second or third pass Michigan raceways.

Subyearlings, density studies in Michigan Raceways: A study to evaluate rearing subyearlings at three densities was initiated in 1997. Over two million subyearling fall chinook salmon were reared in Michigan raceways and released in the Umatilla River. Production equaled the 1997 fiscal year goal (2.6M) and was within 10% of the size goal of 60 fish/lb. Cumulative densities in three Michigan raceways produced 618, 938, and 1,158 fish/gpm in low, medium, and high density series. Rearing cost averaged \$0.05/fish and increased to \$0.13/fish when marking costs were included. More than 2 million salmon were coded or blank wire-tagged in 1996-97 (>92% retention). The ventral fin clip quality was greater than 99% recognizably clipped and descaling was greater (1-9%) in high density raceways than in medium or low density raceways (0-3%). We paint marked the anal fin of 8,000-9,000 fish from each raceway to monitor juvenile migration. The number of marked fish recovered at John Day Dam was less than 6 for each group resulting in recovery of 0.8-1.8%. Smolts required an average of 10 days to travel to John Day Dam.

Yearlings (Umatilla Hatchery): More than 259,000 yearling fall chinook salmon were reared at Umatilla Hatchery in 1996-97. Production exceeded the 1997 fiscal year goal (255K) and the size goal of 8 fish/lb. A single Michigan series produced 161 fish/gpm compared to 85 fish/gpm in an Oregon series of raceways. All yearlings were coded or blank wire-tagged (>99% retention) and ventral fin clipped (>99% recognizably clipped). We estimated 42-71% of fish were partially descaled or descaled in Michigan raceways compared to 0-2% in Oregon raceways. We paint marked the anal fin of 4,000-5,000 fish from each raceway to monitor juvenile migration. The median travel time for smolts to migrate to John Day Dam was 28 days. Relative survival rates to John Day dam were 12.6% (Oregon raceways) and 8.8% (Michigan raceways). No adult recovery is yet available for broods reared at UFH.

Yearlings (Bonneville Hatchery/Little White Salmon Hatchery): Approximately 261,000 yearlings were reared in Oregon raceways at Little White Salmon Hatchery and released in the Umatilla River. Production was below the 1997 fiscal year goal (325K) and the release weight of 13.6 fish/lb was below the size goal (8 fish/lb). All yearlings were coded or blank wire-tagged (>97% retention). We estimated that 13-24% of fish were partially descaled or descaled. No fish were paint marked to monitor juvenile migration in 1997. Adult survival of fish reared at Bonneville Hatchery and released in the Umatilla River ranged from 0.0-0.04% for the 1990-91 broods. Incomplete recovery data from the 1992 brood suggests greater survival, but it is unlikely the 0.75% return goal will be reached.

Adult Returns to the Umatilla River: Counts of fall chinook salmon at Three Mile Falls Dam (TMFD) in 1996 were 646 adults, 80 jacks, and 606 subjacks. Adult returns peaked in mid-October. Based on CWT recoveries, both subyearling and yearling releases contributed to Adult returns. All subjacks originated from yearling releases. We examined more than 60 adult salmon to identify fish marked with body tags.

Fishery: Anglers fished 2,757 h for fall chinook and coho salmon in 1996. Catch rates for fall chinook salmon jacks and adults were 0.02 and 0.06 fish/h. Anglers harvested 14 adult and 162 jack fall chinook salmon. Catch rates for coho salmon averaged 0.01 fish/h and 0.02 fish/h for jacks and adults. Anglers harvested 51 jack and 14 adult coho salmon. We estimated that 67% of the jack fall chinook salmon and 25% of the coho salmon that entered the Umatilla River were harvested between TMFD and the mouth.

Straying: Monitoring suggests that most wire-tagged fish from Umatilla releases are successfully removed at Lower Granite Dam. We estimated only 5 of 50 adults escaped past Lower Granite Dam in

1996. Most Umatilla “strays” originated from 1993 brood subyearlings that were reared at Umatilla Hatchery.

Spring Chinook Salmon

Subyearlings: No subyearling spring chinook salmon were reared at Umatilla Hatchery in 1997. Previous releases have been unsuccessful. Only one coded-wire-tagged fish has been recovered from subyearlings released from 1992-94.

Fall Release: No fish were reared for fall release in 1997. Few CWTs have been recovered from releases made from 1992-94. Survival rates for the 1991 brood reared at Umatilla Hatchery were 0.00-0.01% compared to survival rates of 0.01-0.04% for fish reared at Bonneville Hatchery. Preliminary survival estimates of the 1992-1993 broods reared at Umatilla Hatchery range from 0.00-0.08%. Moreover, current survival rates for the 1993 brood are greater than survival rates for spring release yearlings.

Yearlings: Approximately 225,000 yearling spring chinook salmon were reared at Umatilla Hatchery and released in the Umatilla River in 1997. This was below the 1997 fiscal year goal (390K). Fish were released at 9 fish/lb, compared to the goal of 8 fish/lb. Cost averaged \$0.53/ fish and increased to \$0.57/fish when marking costs were included. Approximately 81,000 fish were coded wire-tagged in 1996-97. Ventral fin clip quality was 99% recognizably clipped and 3% of the yearlings were partially descaled or descaled.

We paint marked 5,000 yearlings to monitor juvenile migration in 1997. Ten percent of these fish were recovered at John Day Dam. Smolt-to-adult survival of yearlings (1991 brood) reared at Umatilla Hatchery ranged from 0.0-0.03% compared 0.13-0.20% for fish reared at Bonneville Hatchery through 1997. Preliminary survival estimates for the 1992 and 1993 broods continue to suggest greater survival for fish reared at Bonneville Hatchery.

Adult Returns to the Umatilla River: The number of spring chinook salmon that returned to the Umatilla River in 1997 was 2,198. Adult returns peaked in mid-May. Few jacks returned in 1997 and from regression analyses we predicted a run of 509 fish (0-1,100 95% CI) in 1998. Analysis of CWT data indicated the majority of returning adults originated from fish reared at Bonneville Hatchery.

Fishery: Anglers fished 3,341 hours in pursuit of spring chinook salmon during the 1997 sport fishery. The reach from TMFD to Barnhart was opened for the first time and anglers fished 812 h for a catch rate of 0.02 fish/h. In the upper reach (Barnhart to the Highway 11 bridge) anglers fished 2,328 h for a catch rate of 0.01 fish/h. Catch rates were lower than in 1996 as fish quickly moved upriver. We estimated that less than 2% (31 fish) of the total run was harvested, well below the 10% quota.

Summer Steelhead

Approximately 137,000 steelhead were released in the Umatilla River in 1997. Steelhead production was lower than the 1997 fiscal year goal (150,000) and fish were larger (4.9 fish/lb) than the goal of 5 fish/lb. Cost averaged \$0.91/fish and increased to \$0.98/fish when marking costs were included. Approximately 59,000 fish were CWT in 1996-97 (>97% retention) and all fish were adipose fin-clipped (>94% recognizably clipped). We estimated 37-89% of the fish were partially descaled or descaled when released.

We paint marked 9,000 fish from the group of steelhead released in May to monitor juvenile migration in 1997. Only 3 marked fish were recovered at John Day Dam, most fish probably spilled over the dam and avoided capture. Data from CWT continues to suggest greater smolt-to-adult survival for groups released in April than for the group released in May. Completed data for the 1992 and 1993 broods showed recovery rates ranging from 0.31-0.78% for April releases compared to 0.0-0.10% for May releases.

Adult Returns to the Umatilla River: The number of 2,477 steelhead counted at Three Mile Falls Dam in 1996-97 was 2,477. Returns of hatchery fish (1,463) were the greatest on record. Run timing for hatchery fish continued to emulate the run timing for wild fish. As in 1995-96, sex ratios for returning hatchery fish were near 1:1 while ratios for wild fish were approximately 1:2 male to female. Of 94 fish sampled for CWT we found 14 strays and by expansion we estimated that 10% of fish of the total Umatilla run were strays. The use of strays for broodstock and mixing with wild spawners should be addressed.

Fishery: We estimated that anglers fished 5,931 h 1996-97. In the lower river anglers fished a total of 3,331 h for a catch rate of 0.02 fish/h and a harvest of 66 ± 27 fish (95% CI). In the upper river anglers fished 2,620 h for a catch rate of 0.04 fish/h and a harvest of 90 ± 31 . We estimated that 3% of the summer steelhead entering the Umatilla River were harvested between TMFD and the mouth of the Umatilla River.

Fish Health Monitoring and Evaluation

Broodstock Monitoring

Monitoring of broodstock for *Renibacterium salmoninarum* (Rs) antigen by the enzyme-linked immunosorbent assay (ELISA) revealed only two cases of clinical level bacterial kidney disease (BKD). One was a Umatilla Hatchery fall chinook salmon spawned at Three Mile Dam Adult Facility and the other was a Umatilla Hatchery summer steelhead spawned at Minthorn Ponds, both for Umatilla Hatchery 96 brood year production.

Adult spring chinook salmon reared as juveniles at Bonneville and Umatilla Hatcheries, collected in the Umatilla River, and spawned at South Fork Walla Walla Adult Facility exhibited low or negative levels of Rs antigen as determined by the ELISA.

Among adult spring chinook salmon carcasses recovered from the Umatilla River and sampled for Rs, one had a moderate, one had a clinical level of BKD from Bonneville Hatchery releases, and one of unknown origin had a clinical level of BKD.

Adult fall chinook salmon pre-spawning mortalities at Three Mile Dam Adult Facility were found to have a high prevalence (57.1%) of *Aeromonas salmonicida* (furunculosis).

All samples collected for viral assays were negative.

Juvenile Monitoring

There were no increased loss investigations or juvenile disease outbreaks for any of the fish populations reared at Umatilla Hatchery or held at acclimation sites. There were no cases of clinical BKD detected or observed in any juveniles examined in this report period. Mostly low, but also a few moderate, levels of Rs antigen were detected by the ELISA in juveniles examined during monthly monitoring. No culturable viruses were detected in any juveniles reared at Umatilla Hatchery.

Flavobacterium psychrophilum, the bacterial agent of coldwater disease (CWD), and *Yersinia ruckeri*, the bacterial agent of enteric redmouth disease, were recovered from smolt mortalities of 95 brood year Carson spring chinook salmon at the Imeques acclimation site. These pathogens had not been recovered during the entire rearing cycle of the fish at Umatilla Hatchery, so this incidence may illustrate pathogen transmission from the natural environment to the hatchery-raised fish.

A preliberation examination of 95 brood year fall chinook salmon at Willard NFH revealed that fish destined for release in the Umatilla River had erythrocytic inclusion body syndrome (10.2% in grab-sampled fish) and notable ongoing loss to CWD, in addition to moderate levels of Rs antigen in some fish.

Prophylactic Treatments

Toxicity responses followed the second treatment of aquamycin on the 95 brood year spring chinook salmon at Umatilla Hatchery. Toxic effects were observed three days after the start of treatment and continued throughout treatment.

Management Implications and Recommendations

Hatchery Monitoring and Evaluation

1. Preliminary CWT data suggests similar smolt-to-adult survival between subyearling fall chinook salmon reared in MI and OR raceways and among subyearlings reared in first, second, and third pass MI raceways. However, the power of the statistical analysis will be low since observed recoveries of CWT's may be less than N=30 for some groups. Total survival for all groups will be less than the master plan goal of 0.3%.
2. The experiment to rear subyearling fall chinook salmon at three densities in Michigan raceways should continue. Growth and condition were similar for fish from all raceways. Comparisons of descaling suggest health benefits from rearing at low densities compared to rearing at standard and high densities. The number of fish that are CWT should be increased for each group to obtain adequate sample sizes for analysis.
3. We recommend subyearling and yearling fall chinook salmon continue to be reared and released in the Umatilla River. Both release strategies contribute adults, but neither strategy consistently produces good survival. Each rearing strategy should be evaluated on a cost per adult basis. Numerous subjacks are produced from yearling releases and this may substantially reduce the number of adults produced. Methods to reduce early maturity should be evaluated.
4. Wire tagging all subyearling fall chinook salmon should continue. We estimated that only 5 of 50 Umatilla fish that arrived at Lower Granite Dam escaped above the dam to mix with wild Snake

River stock. Because a high percentage of wire-tagged fish are removed, elimination of the ventral fin clip should be considered for future broods.

5. The production of subyearling spring chinook salmon should not be resumed until size-at-release goals can be met. Smolt-to-adult survival data for three brood years will not be complete until 1999, but only one CWT adult has been recovered. Further evaluation of this release strategy could be initiated if size-at-release goals can be achieved.
6. Releases of spring chinook salmon in the fall should be reconsidered if space and adequate numbers of eggs are available. Coded-wire tag data suggests that for some broods their survival is greater than spring released fish.
7. Production of yearling spring chinook salmon at Umatilla Hatchery should be reevaluated. Preliminary data indicates significantly greater survival of yearlings reared at Bonneville Hatchery than at Umatilla Hatchery. The rearing profile for yearlings at Umatilla Hatchery differs from rearing at Bonneville Hatchery. Fish at Umatilla Hatchery are chilled as eggs to delay incubation; exhibit fast growth due to rearing at water temperatures greater than 50°F, and they fail to experience cold-water rearing phase in winter. These characteristics may not be suitable for a successful yearling program.
8. The sport fishery for spring chinook salmon should continue when adequate numbers of adults return to TMFD. Managers should consider opening the reach below TMFD increase angling opportunity and harvest. Data from 1997 suggests that in high water years fish quickly move thorough upriver areas open to angling.
9. Production of steelhead should continue in Michigan raceways. Returns of hatchery fish to Three Mile Falls Dam in 1996-97 were the greatest on record. Although we have not reared Umatilla stock concurrently in Michigan and Oregon raceways, we estimate 40% greater production in Michigan raceways per gallon of water. Studies with simultaneous rearing of steelhead in Michigan and Oregon raceways need to be completed before the success of the Michigan system can be fully evaluated.
10. Steelhead smolt-to-adult survival (2.7%) and production goals (150,000) should be reconsidered. Survival of fish reared at Umatilla Hatchery has averaged less than 1.0%, and may only be attainable in years of maximum ocean survival. Survival of Umatilla stock has been similar to survival for fish released in the Wallowa and Imnaha Rivers. Although greater survival might be expected, data on in-basin smolt survival of Umatilla stock is only now being collected.
11. Steelhead straying into the Umatilla basin should be addressed. As many as 10% of returning steelhead to the Umatilla River were hatchery strays, primarily from the Snake River system. Reading CWT's before spawning to selectively remove strays may be needed if straying or the use of hatchery fish as broodstock increases. In addition, more than 250 stray fish were estimated to enter the basin. Studies should be designed to determine whether strays are breeding with wild spawners.
12. Rearing steelhead for release in May should be reevaluated. These fish continue to perform poorly. Adult survival from three broods have been 5-10 times poorer for May releases compared to April releases. Options include earlier release dates, accelerated growth profile, and shorter acclimation times.

13. Alternative water supplies should be investigated at Umatilla Hatchery. Partial justification for the construction of Umatilla Hatchery was to compare the adult survival of salmonids reared in Michigan and Oregon raceways. Water shortages at the Umatilla Hatchery continue to limit production and experiments that could produce information for other Columbia River basin hatcheries.

Fish Health Monitoring and Evaluation

1. Implement culling of eggs and/or segregated rearing strategies, based on the level of *Renibacterium salmoninarum* (Rs) in the female parent, for reducing the impact of bacterial kidney disease (BKD). One-hundred percent sampling of female adult chinook salmon for Rs must be employed because subsampled data severely weakens the analyses of subsequent occurrences of BKD in the progeny.
2. Continue to sample 100% of coded-wire tagged adult chinook salmon to obtain sufficiently valid statistical samples for comparison of Rs infection levels versus rearing strategy, including hatchery of origin.
3. Implement and maintain rearing strategies that seek to reduce stress and/or evaluate the effects of potential stress reducing rearing strategies.
4. Minimize or eliminate the practice of stocking fish into the Umatilla basin, known to have significant prevalences of serious salmonid fish pathogens, to minimize the impact on natural or other hatchery-produced fish.
5. Prophylactic injections of oxytetracycline (OTC) should be implemented in future years to reduce the infection rate and the pre-spawning mortality due to furunculosis. Prophylaxis should be given as intraperitoneal injections of OTC at a dosage of 10 mg per Kg of fish body weight. This injection should be administered at the time the fish are sorted into the holding ponds.

REPORT A

Umatilla Hatchery Monitoring and Evaluation

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UMATILLA HATCHERY MONITORING AND EVALUATION

INTRODUCTION

The Northwest Power Planning Council's Columbia River Basin Fish and Wildlife Program authorized construction of Umatilla Hatchery (UFH) in 1986. Measure 703 of the program amended the original authorization for the hatchery and specified evaluation of the Michigan (MI) raceways using oxygen supplementation to reach production goals of 290,000 lb of chinook salmon (*Oncorhynchus tshawytscha*) and steelhead (*O. mykiss*). The hatchery was completed in fall 1991. Partial justification for the hatchery was to develop considerable knowledge and understanding of new production and supplementation techniques. MI raceways were used at UFH to increase smolt production with a limited water supply and for comparison of MI raceways with Oregon (OR) raceways. Test results for MI raceways will have systematic application in the Columbia River basin.

The Umatilla Hatchery is the foundation for rehabilitating chinook salmon and enhancing steelhead in the Umatilla River (CTUIR and ODFW 1990) and is expected to contribute significantly to the Northwest Power Planning Council's goal of doubling salmon production in the Columbia Basin. Hatchery production goals and a comprehensive monitoring and evaluation plan were presented in the Umatilla Hatchery Master Plan (CTUIR and ODFW 1990). The Comprehensive Plan for Monitoring and Evaluation of Umatilla Hatchery (Carmichael 1990) was approved by the Northwest Power Planning Council as a critical adaptive management guide for fisheries rehabilitation in the Umatilla River. Monitoring and evaluation will be used to increase knowledge about uncertainties inherent in the fisheries rehabilitation and will complement the developing systematic monitoring and evaluation program.

The monitoring and evaluation goals are:

1. Provide information and recommendations for the culture and release of hatchery fish, harvest regulations, and natural escapement to accomplish long-term natural and hatchery production goals in the Umatilla River basin that are consistent with provisions of the Council's Columbia River Basin Fish and Wildlife Program.
2. Assess the success of achieving the management objectives in the Umatilla River basin that are presented in the Master Plan and the Comprehensive Rehabilitation Plan.

A substantial proportion of the production at UFH is reared in MI raceways. This system has not been thoroughly evaluated to determine the effects on smolt-to-adult survival. In addition, the rearing strategies proposed for spring chinook salmon require an unusually extensive period of incubation in chilled well water.

Extensive background and justification for Umatilla Hatchery monitoring and evaluation is presented in Carmichael (1990). In this report, we present a review of our activities and findings for the Umatilla Hatchery Monitoring and Evaluation Project from 1 November 1996 to 31 October 1997. We designed our program to evaluate fish cultural practices, conduct rearing and survival studies, assess sport fisheries, and provide information for planning and coordination. Additional studies have been designed for fall chinook salmon to evaluating straying and the effects of tagging.

We monitored the culture and performance of more than 3.2 million chinook salmon and steelhead produced at UFH in 1996-97 (Appendix Tables 2-8). Individual stock profiles, release, performance, and return data of previously released groups are presented in the following sections.

STUDY SITE

Umatilla Hatchery is located approximately seven miles west of the town of Irrigon, Oregon. The hatchery is operated under a cooperative agreement among the Oregon Department of Fish and Wildlife (ODFW), the Confederated Tribes of the Umatilla Indian Reservation (CTUIR), the Bonneville Power Administration, the U.S. Fish and Wildlife Service, and the U.S. Army Corps of Engineers.

The hatchery was designed to produce salmonids in oxygen supplemented MI raceways and in non-oxygen supplemented OR raceways. Specific data about the hatchery is available in the Umatilla Hatchery Master Plan (CTUIR and ODFW 1990) and in the Environmental Assessment Report (Bonneville Power Administration 1987). The MI system consists of eight series of three concrete raceways. Water flows from the upper raceway to the middle raceway and then to the lower raceway within each series. Before the water enters each raceway, pure oxygen is supplemented through an oxygen contact column. More detailed descriptions of the raceways are presented in Focher et al. (1998).

The Umatilla River and tributaries are located in Umatilla, Morrow, and Union counties, Oregon. Broodstock facilities are located at TMFD (fall chinook and coho salmon), South Fork Walla-Walla River (spring chinook salmon), and Minthorn Springs (MS) at river mile 64, Umatilla River. Acclimation facilities include MS, Thornhollow (TH) at river mile 73.5, Imeques C-mem-ini-kem (IC) at river mile 80, and Bonifer Springs (BS) at river mile 2 of Meacham Creek (Figure 1).

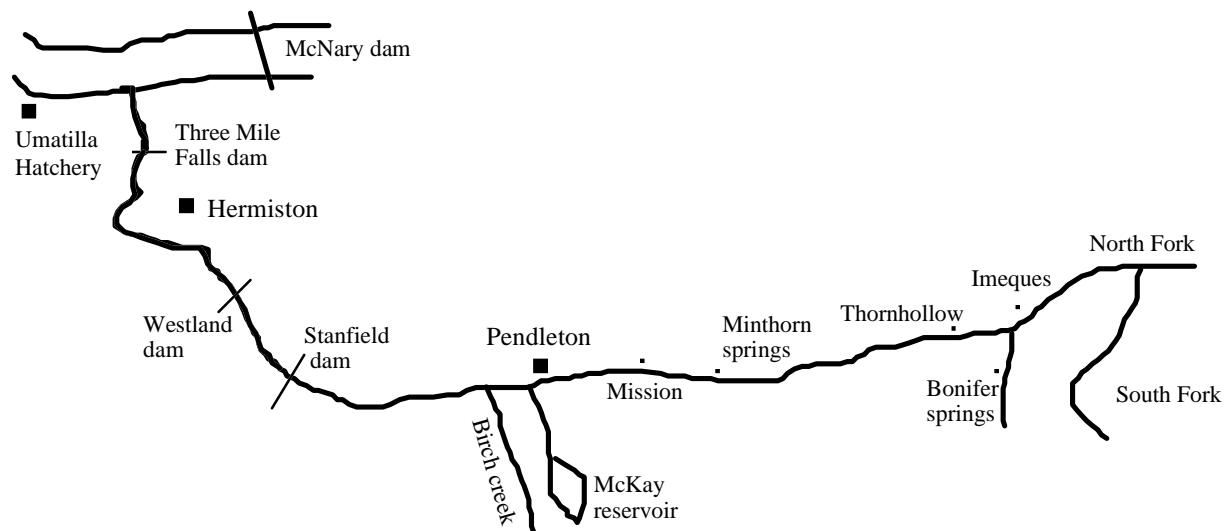


Figure 1. Location map, Umatilla River.

FALL CHINOOK SALMON

Overview

Six brood years of subyearling fall chinook salmon (1991-96) have been reared in MI or OR raceways at UFH and released in the Umatilla River (Appendix Table 2). A previous study (1991-95 broods) evaluated the success of rearing subyearlings in MI and OR raceways. Beginning with the 1996 brood we evaluated rearing subyearlings at different densities in Michigan raceways. Yearlings have also been reared and released in the Umatilla River (Appendix Table 3). These fish provide additional production and an alternative release strategy.

Methods

Subyearlings

Juvenile Rearing and Survival Studies: Methods to monitor water quality, juvenile rearing, hatchery operation practices, and costs at UFH were described in 1992-96 annual reports (Keefe et al. 1993, 1994; Hayes et al. 1996a, 1996b, Focher et al. 1998). Most methods used in rearing and survival studies were described in the 1992-1996 annual reports (Keefe et al. 1993, 1994; Hayes et al. 1996a, 1996b, Focher et al. 1998).

The incubation of fall chinook salmon embryos from Umatilla and Priest Rapids. stocks were monitored to eye, hatch, and swim-up at different temperatures. Fertilized water hardened eggs were transported to UFH and 100-300 individuals from different family groups were incubated in nitex baskets in Heath incubator trays. Eyeing at hatch percentages, hatch and swim-up lengths (mm), and deformities were determined after 95% of the individuals within each basket reached that stage.

In 1996 we used a paint instead of cold-branding to mark fish for juvenile migration studies. Subyearlings were paint marked at Umatilla Hatchery with an aqueous solution of latex encapsulated fluorescent pigment (5-8 μ m diameter microspheres) developed by New West Technologies (Santa Rosa, California). Fish were randomly collected from each raceway, transported to a tagging trailer, anesthetized, marked, and returned to their original raceway. We marked the anal fin by holding the fish underwater and positioning the fin against a white ceramic tile to provide a solid backing. Paint was applied using a pressurized CO₂ injector (600 p.s.i.) that forced paint through a marking gun. The marking gun was positioned at an angle so that paint could be forced into several fin rays. Different colors were used to identify groups of fish from each raceway. Subsamples of fish were examined after 24 h to determine the quality of each mark. Marks were categorized as 1) good - if two or three rays were clearly marked; 2) fair - only 1 or fewer rays were marked, but the mark was clearly visible; 3) poor - mark was not clearly visible, paint mark was very small; 4) none - no mark was visible.

Adult Survival Studies: Methods to determine smolt-to-adult survival were described in the 1992-96 annual reports (Keefe et al. 1993, 1994; Hayes et al. 1996a, 1996b, Focher et al. 1998). Data for fall chinook salmon was downloaded from the Pacific States Marine Fisheries Commission (PSMFC) database in September 1997

Effects of Tagging and Marking: Methods were described in the 1992-96 annual reports (Keefe et al. 1993, 1994; Hayes et al. 1996a, 1996b, Focher et al. 1998) except for the following modification. We used a correction factor of 0.58 to calculate the number of fish with body tags. To determine the correction factor we dissected 29 fish that had produced a positive result (presence of a body tag) when examined with a tunnel-type wire detector. If a body-tag was found during dissection, the fish was recorded as a body-tagged fish. The fish was recorded as untagged if no body-tag was found. The correction factor was calculated as the proportion of fish with wire tags compared to the number examined.

Yearlings

Juvenile Rearing and Survival Studies: Methods to monitor rearing and survival were the same as described for subyearlings.

Adult Survival Studies: Methods to determine smolt-to-adult survival were the same as described for subyearlings. When groups were released at approximately the same time, yearlings reared at UFH were compared to groups reared at Bonneville Hatchery (BFH).

Adult Returns to the Umatilla River

Methods to calculate adult returns were reported in Hayes et al. (1996b).

Fishery

Except for the following modifications, methods to survey the fall chinook and coho salmon sport fishery in 1996 were described in the 1993-96 annual reports (Keefe et al. 1993, 1994; Hayes et al. 1996a, 1996b, Focher et al. 1998). The fall chinook and coho salmon sport fishery was open 1 September to 30 November 1996. Fishing was allowed from Stanfield Dam downstream to the Highway 730 bridge in Umatilla. We did not survey between TMFD and Stanfield Dam because there was not a significant amount of effort observed during the 1996 season. However, spot checks did indicate occasional angling in this area. Anglers were allowed to harvest 2 adult coho salmon per day and 5 coho (16-20 in) or chinook (16-24 in) jacks per day. Adult chinook salmon could be harvested below Highway 730. Anglers were restricted to barbless hooks. The percent of the run harvested was calculated by dividing number harvested by the fish count at TMFD plus the estimated number harvested below TMFD.

Straying

Methods to estimate fall chinook salmon strays into the Snake River were described in Hayes et al. 1996b. Additional estimates were calculated with an unpublished model developed by the National Marine Fisheries Service.

Statistical Analyses

Most tests comparing parameters between MI and OR systems and among passes within each system were analyzed using analysis of variance (ANOVA) at the 0.05 significance level. For tests of a single brood year we used a nested ANOVA to separate sources of variation within the MI and OR systems. Nesting levels included system, raceway within system, and pass within raceway.

Sources of variation among brood years were separated into brood year, system, and/or pass. Data with heterogeneous variances or listed as percentages were transformed as recommended (Sokal and Rohlf 1981). In some tests percentage data were compared with the Kruskal-Wallis or Wilcoxon non-parametric tests. Differences between pairs of means were tested by the Wilcoxon method.

Only A and B passes were compared in the OR and MI systems. Tests designed to examine differences within the MI system included A, B, and C passes. All other tests, including planned comparisons of differences between means using the Sidak technique (Sokal and Rohlf 1981) were evaluated at an alpha level =0.05.

Results

Subyearlings, rearing in Michigan and Oregon Raceways

Overview: Five brood years of subyearling fall chinook salmon (1991-95) have been reared in MI and OR raceways at UFH and released in the Umatilla River (Appendix Table 2). The objectives of this study are to compare rearing conditions, juvenile migration, cost, and smolt-to-adult survival for subyearlings produced in MI and OR systems and among fish reared in different MI passes at the design densities.

Juvenile Rearing and Survival Studies: Juvenile rearing and survival data was presented in previous annual reports.

Adult Survival Studies: Smolt-to-adult survival estimates are presented in Table 1.

Subyearlings, density studies in Michigan raceways

Overview: We evaluated rearing subyearlings at three densities in Michigan raceways starting with the 1996 brood. The objectives of this study are to compare rearing conditions, migration, smolt-to-adult survival, and cost for subyearlings produced in MI raceways at densities of 200,000, 300,000, and 400,000 fish per raceway. Because of limited water supply and numbers of fish produced, each raceway represents a unique density-by-pass combination. This experiment will be conducted for four years to provide replication.

Juvenile Rearing and Survival Studies: Data on juvenile rearing, results of the study to examine eyeing and hatching survival and release data are presented in Tables 2-6 and Appendix Tables 1 and 2. Subyearlings from the 1996 brood were ponded outside in four OR raceways on 12 February 1997 at 950 fish/lb. These groups were split into nine MI raceways at the end of March. Marking with wire tags and right ventral fin clips started in early April and was completed in early May. Because of a counting error

Table 1. Exploitation and survival of subyearling fall chinook salmon coded-wire-tagged (CWT) and released in the Umatilla River, 1991-93 brood years. Recoveries include age 3 and older fish and are incomplete for all brood years. Estimates of number of jacks and adults recovered are based on total production in each raceway. Data was downloaded in September 1997.

Brood year, CWT code	Raceway	N ^a	Total exploit- ation rate (%)	Umatilla return rate (% of release)	Total survival rate (% of release)	Number of jacks and adults recovered
1991						
071433	M2A	0	0.0	0.000	0.000	0
071434	M3A	0	0.0	0.000	0.000	0
071435	M2B	0	0.0	0.000	0.000	0
071436	M3B	1	0.0	0.000	0.000	10
071437	M2C	1	0.0	0.003	0.003	7
071438	M3C	0	0.0	0.000	0.000	0
subtotal		2	0.0	0.001	0.001	17
071430	O2A	0	0.0	0.000	0.000	0
071429	O3A	1	0.0	0.003	0.003	9
071432	O2B	0	0.0	0.000	0.000	0
071431	O3B	0	0.0	0.000	0.000	0
subtotal		1	0.0	0.001	0.001	9
Total		2	0.0	0.001	0.001	26
1992						
076330	M2A	3	100.0	0.000	0.010	30
076331	M3A	6	50.0	0.010	0.020	57
070127	M2B	11	72.7	0.011	0.041	109
076333	M3B	8	37.5	0.017	0.027	74
076334	M2C	5	20.0	0.013	0.017	47
076332	M3C	2	0.0	0.007	0.007	19
subtotal		35	51.4	0.010	0.020	337
070126	O2A	9	11.1	0.024	0.030	82
070125	O3A	9	55.6	0.014	0.031	84
076329	O2B	7	42.9	0.013	0.023	46
076335	O3B	13	30.8	0.030	0.043	89
subtotal		38	34.2	0.020	0.032	300
Total		73	42.5	0.014	0.025	637

^a Expanded CWT recoveries.

Table 1 (continued)

Brood year, CWT code	Raceway	N ^a	Total exploit- ation rate (%)	Umatilla return rate (% of release)	Total survival rate (% of release)	Number of jacks and adults recovered
1993						
070663	M2A	0	0.0	0.000	0.000	0
070719	M3A	4	0.0	0.013	0.013	41
070720	M2B	4	0.0	0.013	0.013	41
070723	M3B	3	0.0	0.010	0.010	32
070722	M2C	6	16.7	0.016	0.019	59
070721	M3C	4	0.0	0.011	0.014	43
subtotal		21	0.0	0.010	0.011	217
070662	O2A	5	0.0	0.013	0.016	45
070718	O3A	1	0.0	0.003	0.003	9
070716	O2B	7	28.6	0.013	0.023	44
070717	O3B	6	0.0	0.018	0.018	35
subtotal		21	10.5	0.012	0.015	133
Total		40	7.5	0.011	0.013	350

Table 2. Egg-take and survival of subyearling fall chinook salmon reared at Umatilla Hatchery, brood years 1991-96

Egg source	Brood year	Number of eggs taken or received	Egg-to-fry survival (%)	Egg-to-smolt survival ^a (%)
Bonneville Hatchery ^b	1991	2,872,000	88.2	84.9
Umatilla River ^c	1991	601,548	85.4	84.8
Total		3,473,548		
Bonneville Hatchery	1992	1,615,003	99.0	
Little White Salmon NFH	1992	992,668	99.0	
Umatilla River	1992	181,419	92.0	
Total ^d		2,189,090	98.6	94.3
Priest Rapids	1993	3,181,000	81.7	
Umatilla River	1993	352,000	76.1	
Total		3,533,000	81.1	80.4
Priest Rapids	1994	3,877,000	67.4	63.6
Priest Rapids ^e	1995	4,547,108	78.1	75.7
Priest Rapids	1996	3,358,649	73.2	
Umatilla River	1996	778,028	63.6	
Total		4,136,677	71.3	62.4

^a Survival estimate is based on green egg-to-smolt stage.

^b Eggs incubated at Bonneville Hatchery. Survival estimate does not include 2,403 parr removed for passage evaluation.

^c Survival estimate does not include 5,401 smolts removed for passage evaluation.

^d Survival estimate does not include 31,600 smolts removed for passage evaluation.

^e Survival estimate adjusted for 602,100 excess eggs destroyed.

Table 3. Eyeing and hatching survival of fall chinook salmon from Umatilla and Priest Rapid stocks incubated at different temperatures.

Stock	Initial temperature °C	Hatching %	Hatching length (mm)	Swim-up length (mm)
Umatilla	7.2	68.7	27.0	37.7
Umatilla	8.9	88.3	26.4	39.3
Umatilla	13.9	90.0	24.5	37.9
Priest Rapids	7.8	85.0	25.3	38.5
Priest Rapids	10.5	90.0	25.7	38.2

Table 4. Rearing conditions immediately before transfer for subyearling fall chinook salmon at three densities in Michigan series at Umatilla Hatchery, 1997.

Brood year	Series	Target number per raceway	Maximum density (lb/ft ³)	Maximum loading (lb/gal/min)	Number reared per gpm
1996	M4	200,000	1.0-1.1	2.3-2.7	617
1996	M1	300,000	1.6-1.7	3.7-3.9	940
1996	M2	400,000	1.7-2.1	4.0-4.9	1,159

Table 5. Water quality in three Michigan series used to rear subyearling fall chinook salmon at three densities in 1997. Values are means.

Parameter measured	Raceway/Density								
	200K			300K			400K		
	M1A	M1B	M1C	M2A	M2B	M2C	M3A	M3B	M3C
Temperature head (d-C)	11.9	12.1	11.9	11.5	11.6	11.8	11.7	11.7	11.9
Temperature tail (d-C)	11.9	11.9	11.9	11.8	11.9	11.8	11.6	11.8	11.8
pH head	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.8	7.7
pH tail	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7
Oxygen head (ppm)	11.3	10.8	10.5	11.4	11.7	10.9	11.2	11.3	12.4
Oxygen tail (ppm)	8.9	8.8	8.7	9.0	9.6	9.3	9.0	9.2	9.4
Nitrogen head (mmHg)	597	565	496	566	552	559	610	598	539
Nitrogen tail (mmHg)	595	520	511	567	543	555	621	615	552
Total pressure-head (mmHg)	763	734	680	747	732	717	770	763	722
Total pressure-tail (mmHg)	735	675	652	718	703	690	753	749	695
Unionized ammonia (ug/l)	0.92	1.77	1.79	1.23	1.50	1.32	1.32	2.90	1.10
Alkalinity (mg/l CaCO ₃)	138	136	137	140	140	138	143	142	143

Table 6. Mean length, weight, and condition factor for subyearling fall chinook salmon reared at three densities in Michigan raceways at Umatilla Hatchery in 1997, 1996 brood.

Sample Density	Pass	Length(mm)		Weight(g)		Condition Factor	
		N	Mean(SE)	N	Mean(SE)	N	Mean(SE)
Mar 15:							
200K	A	129	59.5(0.4)	74	2.3(0.1)	74	1.09(0.02)
	B	103	59.9(0.4)	60	2.3(0.1)	60	1.10(0.01)
	C	109	60.2(0.4)	34	2.9(0.1)	34	1.22(0.02)
Mar 15:							
300K	A	111	61.0(0.4)	74	2.8(0.1)	74	1.12(0.01)
	B	102	59.7(0.4)	70	2.5(0.1)	70	1.20(0.02)
	C	110	60.4(0.4)	110	2.6(0.1)	110	1.14(0.01)
Mar 15:							
400K	A	104	59.5(0.4)	89	2.6(0.1)	89	1.19(0.01)
	B	132	57.9(0.4)	64	2.3(0.1)	64	1.19(0.02)
	C	113	60.3(0.3)	68	2.7(0.1)	68	1.24(0.01)
April 1:							
200K	A	105	64.4(0.4)	47	3.4(0.1)	47	1.26(0.02)
	B	106	64.3(0.4)	49	3.5(0.1)	49	1.32(0.02)
	C	100	64.8(0.5)	59	3.6(0.1)	59	1.33(0.02)
April 1:							
300K	A	101	65.2(0.5)	56	3.5(0.1)	56	1.18(0.01)
	B	98	67.3(0.5)	59	3.5(0.1)	59	1.11(0.02)
	C	102	68.3(0.5)	53	4.3(0.2)	53	1.28(0.02)
April 1:							
400K	A	105	65.4(0.5)	65	3.2(0.1)	65	1.14(0.02)
	B	106	64.8(0.6)	50	3.7(0.1)	50	1.25(0.02)
	C	105	68.1(0.4)	47	4.2(0.2)	47	1.27(0.02)
April 15:							
200K	A	106	70.5(0.9)	50	4.4(0.2)	50	1.21(0.01)
	B	97	73.6(0.5)	59	4.6(0.1)	59	1.14(0.01)
	C	117	75.3(0.5)	51	4.9(0.2)	51	1.13(0.02)
April 15:							
300K	A	98	75.6(0.7)	69	5.7(0.2)	69	1.24(0.01)
	B	106	73.1(0.5)	52	4.5(0.2)	52	1.15(0.02)
	C	99	73.6(0.6)	55	4.8(0.2)	55	1.19(0.02)

Table 6 (continued)

Sample Density	Pass	Length(mm)		Weight(g)		Condition Factor	
		N	Mean(SE)	N	Mean(SE)	N	Mean(SE)
April 15: 400K	A	109	71.9(0.5)	51	4.5(0.2)	51	1.19(0.02)
	B	100	73.8(0.6)	59	4.7(0.2)	59	1.12(0.01)
	C	107	76.2(0.5)	51	4.6(0.1)	51	1.06(0.01)
Pre-release: 200K	A	308	75.4(0.4)	207	4.9(0.1)	207	1.11(0.01)
May 8	B	326	77.3(0.3)	209	5.3(0.1)	209	1.12(0.01)
	C	311	79.7(0.3)	200	5.9(0.1)	200	1.14(0.01)
Pre-release: 300K	A	309	79.5(0.4)	203	5.6(0.1)	203	1.06(0.01)
May 8	B	310	78.3(0.4)	211	5.8(0.1)	211	1.16(0.01)
	C	343	78.0(0.3)	231	5.3(0.1)	231	1.08(0.01)
Pre-release: 400K	A	338	75.5(0.4)	202	4.9(0.1)	202	1.10(0.01)
May 8	B	295	77.9(0.4)	229	5.4(0.1)	229	1.11(0.01)
	C	301	78.1(0.4)	198	5.7(0.2)	198	1.17(0.01)
Release: 200K	A		83.4		6.8		1.16
May 29-30	B		84.6		6.5		1.07
	C		87.0		6.9		1.05
Release: 300K	A		87.1		7.1		1.08
May 29-30	B		86.2		7.3		1.14
	C		85.5		6.8		1.09
Release ^a : 400K	A		82.7		6.7		1.18
May 29-30	B		85.4		6.4		1.03
	C		83.7		6.7		1.15

^a Release length was calculated from 1,800 fish and release weight and condition factor from 1,200 fish released on May 29-30, 1997.

we reared only 311,000 fish in a raceway that was planned to produce 400,000 fish. Production in each Michigan series averaged 951 fish per gallon per minute (gpm). Fish numbers averaged 199,540, 299,817, and 366,920 respectively in low, medium, and high density raceways. Average production costs for all raceways combined were \$0.05 per fish and increased to \$0.135 per fish when marking costs were included.

Smolt data at pre-release and release for the 1996 brood is presented in Tables 5-7. Most subyearlings were classed as intermediate smolts and 0-29% identified as smolts at pre-release in 1997. Little erosion of the dorsal, caudal, or paired fins was observed.

Paint mark, coded-wire-tag, and production release and recovery data is presented in Table 8 and Appendix Table 2. The percent of fish recognizably right ventral clipped was 99.5%. We estimated that 80-91% of the paint marks applied to the anal fin were readable. Only 12 paint-marked fish were observed at John Day dam (4 blue, 2 dark-orange, 6 pink). Estimated daily passage and percent recovery was 104 (1.3% blue), 73 (0.8% dark orange), and 150 (1.8% pink). Subyearlings were released on 29-30 May and the first paint marked fish were observed at John Day dam on 7 June and the last on 16 June. Fifty percent of the fish were recovered within 10 days and 90% within 15 days of release.

Adult Survival Studies: No smolt-to-adult survival estimates are available. The first adult returns are expected in 1999.

Effects of Tagging and Marking: We identified 63 adults that may have carried body tags in fall 1996. Final counts after corrections for false positive readings appear in Table 9.

Yearlings

Overview: Two brood years (1994-95) of yearlings have been reared in MI and OR raceways at UFH and released in the Umatilla River. Egg incubation and rearing at UFH is designed to produce smolts that are approximately 8-10 fish per pound at release. In prior years, yearlings were reared solely at BFH and in 1996-97 fish were reared at LWSH. The objectives of this study are to monitor rearing conditions, juvenile migration, cost, and smolt-to-adult survival for yearlings produced in MI or OR raceways and among fish reared in different MI passes. Because the best rearing strategy for fall chinook salmon is unknown, we will compare smolt-to-adult survival and rearing costs of yearling and subyearling releases from all hatcheries. We may rear yearlings at UFH in the future when space is available; however, propagation of yearling spring chinook salmon is a priority. Data from completed adult returns of fish reared at UFH will be available in 2002.

Umatilla Hatchery

Juvenile Rearing and Survival Studies: Data on juvenile rearing and releases is presented in Tables 10-11 and Appendix Tables 1 and 3. We received 484,386 eggs from Priest Rapids Hatchery for the yearling program. Egg-to-smolt survival was 54%. Yearlings were ponded outside in one OR raceway on 29 June 1996 at approximately 309 fish/lb. They were split into three MI raceways on 25 July 1996 and the final split into three MI and two OR raceways was on 1 August 1996. Marking with wire tags and right ventral fin clips was completed in July. Food conversion ratios ranged from 0.93-1.04 in MI raceways and were 0.95 in both OR raceways. To improve fish health, the baffles were removed from all raceways on 23 October 1996 (see report B). A single MI series of raceways (3 passes)

Table 7. Mean proportion of descaled, partially descaled, and undamaged subyearling fall chinook salmon reared at three densities in Michigan raceways, Umatilla Hatchery, 1996 brood.

Brood year	Raceway	Density	Descaled ^a	Partially descaled ^b	Undamaged ^c
1996	M4A	200	1.0	6.7	92.3
1996	M4B	200	0.0	5.7	94.3
1996	M4C	200	0.0	3.5	96.5
1996	M1A	300	2.5	35.5	62.1
1996	M1B	300	0.0	17.5	82.5
1996	M1C	300	0.4	44.8	54.7
1996	M2A	400	0.5	12.4	87.1
1996	M2B	400	1.3	32.8	65.9
1996	M2C	400	8.6	57.6	33.8

^a More than 0.20 descaling on either side of the fish.

^b Descaling = 0.03 to 0.20 on either side of the fish.

^c Less than 0.03 descaling on either side of the fish.

Table 8. Coded-wire tag and paint mark information for subyearling fall chinook salmon marked at Umatilla Hatchery and released in 1997, 1996 brood (CWT = coded-wire-tag, AD = adipose fin, RV = right ventral fin).

Raceway	CWT code	Number CWT ^a	Paint mark		Fin Location	Fin clip	Number released
			Number	Color			
M1A	092129	33,161	8,469	Pink	Anal	RV/ADRV	294,417
M1B	092131	32,464				RV/ADRV	294,043
M1C	092132	31,382				RV/ADRV	304,993
M2A	092131	31,844	8,094	Blue	Anal	RV/ADRV	395,493
M2B	092133	33,273				RV/ADRV	394,250
M2C	092134	33,460				RV/ADRV	311,016
M4A	092126	33,555	9,000	Dark- orange	Anal	RV/ADRV	197,028
M4B	092127	32,764				RV/ADRV	195,031
M4C	092128	29,732				RV/ADRV	194,562

^a Number recognizably CWT and released. All CWT fish were adipose fin clipped. All fish were right ventral fin clipped and all non-CWT fish were marked with a blank-wire tag.

Table 9. Recovery of marked adult fall chinook salmon that returned to Three Mile Falls Dam in the Umatilla River from 1992 to 1996. Marking evaluation was initiated in 1991 at Irrigon Hatchery and continued in 1992 and 1993 at Umatilla Hatchery (AD = adipose fin clip, BT = body tag, CWT = coded-wire-tag, LV = left ventral fin clip, and RV = right ventral fin clip).

Brood year ^a	Mark	Number released	CWT code	Number Recovered						
				1992	1993	1994	1995	1996	Total	(%)
1990	BT	147,586	-	-	2	13	15	2	32	0.022
	AD+CWT	51,814	075450	1	2	15	5	0	23	0.044
		52,444	075451	2	3	6	2	0	13	0.025
	AD+CWT+RV	52,252	075225	0	1	10	4	0	15	0.029
		51,728	075226	0	2	0	3	3	7	0.014
	AD+CWT+BT	48,266	075328	3	3	6	4	0	16	0.033
		48,481	075499	2	1	12	4	0	19	0.039
		48,301	070016	0	1	5	4	1	11	0.023
1991	LV	69,816	-	-	1	4	1	3	9	0.006
		74,408	-	-						
	BT+LV	67,144	-	-	0	0	0	1	1	0.001
		65,749	-	-						
	BT	65,184	-	-	2	5	1	2	10	0.015
		70,435	-	-						
	AD+CWT+RV	32,278	071430	-	0	0	0	1	1	0.003
		31,892	071429	-	0	1	0	0	1	0.003
1992	LV	61,801	-	-	-	12	9	14	35	0.027
		66,204	-	-	-					
	BT+LV	68,644	-	-	-	7	7	6	20	0.029
		70,442	-	-	-					
	BT	69,225	-	-	-	7	12	6	25	0.036
		69,518	-	-	-					
	AD+CWT+RV	29,594	070126	-	-	0	5	1	6	0.020
		29,360	070125	-	-	2	4	3	9	0.031

^a Fish not CWT were assigned to a brood year by length frequency data and cwt percents.

Table 10. Rearing conditions immediately before transfer for yearling fall chinook salmon in Michigan and Oregon raceways at Umatilla, Bonneville, and Little White Salmon hatcheries.

Brood year	System	Density (lb/ft ³)	Loading (lb/gal/min)	Number reared per gpm
Umatilla Hatchery				
1994	Oregon	3.9-4.0	9.5	151
1995	Michigan	2.6-3.0	6.2-7.1	165
1995	Oregon	1.0-1.1	4.9-5.3	82
Bonneville Hatchery				
1994	Oregon	0.8-1.0	6.0-7.0	58
Little White Salmon Hatchery				
1995	Oregon	1.4-2.6	4.1-7.5	69

Table 11. Water quality in first and second pass Michigan and Oregon raceways used to rear yearling fall chinook salmon in 1996-97, 1995 brood. Means without letters are not significantly different at $P>0.05$.

Parameter measured	Michigan		Oregon	
	N	Mean	N	Mean
Sampling period	Jul 24 - Feb 15		Jul 24 - Feb 15	
Temperature head (°C)	58	13.4	63	13.3
Temperature tail (°C)	58	13.4	63	13.5
pH head	56	7.8	61	7.8
pH tail	56	7.8	61	7.8
Oxygen head (ppm)	56	11.1a	61	10.1b
Oxygen tail (ppm)	56	9.4a	61	8.5b
Nitrogen head (mmHg)	56	590a	61	601b
Nitrogen tail (mmHg)	56	604a	61	619b
Total pressure-head (mmHg)	56	756	61	752
Total pressure-tail (mmHg)	56	747	61	748
Unionized ammonia (µg/l)	26	0.68	30	0.61
Alkalinity (mg/l CaCO ₃)	28	132	32	134

Table 12. Water quality in first, second, and third pass Michigan raceways used to rear yearling fall chinook salmon in 1996-97, 1995 brood. Sample size for C pass in parentheses.

Parameter measured	N	Mean parameter value		
		A pass	B pass	C pass
Sampling period		Aug 2 - Feb 15	Aug 2 - Feb 15	Aug 2 - Feb 15
Temperature head (°C)	29(28)	13.4	13.5	13.5
Temperature tail (°C)	29(28)	13.3	13.5	13.5
pH head	28(27)	7.8	7.9	7.8
pH tail	28(27)	7.9	7.8	7.8
Oxygen head (ppm)	28(27)	11.3	10.9	11.2
Oxygen tail (ppm)	28(27)	9.5	9.3	9.3
Nitrogen head (mmHg)	28(27)	589	590	557
Nitrogen tail (mmHg)	28(27)	605	604	600
Total pressure-head (mmHg)	28(27)	757	755	753
Total pressure-tail (mmHg)	28(26)	748	745	741
Unionized ammonia (µg/l)	13(13)	0.51	0.85	0.13
Alkalinity (mg/l CaCO ₃)	14(14)	131	132	134

produced 161 fish/gpm compared to 85 fish/gpm in OR raceways. Production costs in MI raceways were \$1.19 per fish compared to \$1.15 per fish in OR raceways. When marking costs were included, cost increased to \$1.28 and \$1.24 per fish in MI and OR raceways, respectively.

Smolt condition data at pre-release and release appear in Tables 13-14. The percentage of smolts ranged from 98-100% at pre-release. We found that 7-15% of the fish examined had split or torn caudal fins. Paint mark, coded-wire-tag, and production release and recovery data is presented in Table 15 and Appendix Table 3. Personnel at John Day dam observed 44 paint marked fish (27 OR, 17 MI). Estimated total passage for the migration season and percent recovery was 606 (12.6% OR) and 368 (8.8% MI). Yearlings released on 25 March were first observed at John Day dam on 9 April and last observed on 30 April. Fish from MI and OR raceways appeared to travel at a similar rate. Combined recoveries were 50% within 28 days and 90% within 34 days of release.

Adult Survival Studies: Adult recovery data from previous CWT releases is presented in Table 16. At this time only age 2 fish have been recovered from fish reared at UFH.

Little White Salmon Hatchery

Juvenile Rearing and Survival Studies: Data on juvenile rearing and releases is presented in Table 10 and Appendix Tables 1 and 3. Smolt condition data at pre-release and release is provided in Tables 13-14. The percentage of fish classified as smolts ranged from 16-46%; most fish were classified as intermediate smolts. Fin condition was generally good, but 2-5% of fish had split caudal fins and 1-2% had split dorsal fins. Coded-wire-tag and production release data is presented in Table 15 and Appendix Table 3.

Adult Survival Studies: Smolt-to-adult survival estimates are not yet available.

Bonneville Hatchery

Juvenile Rearing and Survival Studies: No yearlings from BFH were released in the Umatilla River in 1997. Juvenile rearing and survival data was presented in previous annual reports.

Adult Survival Studies: Smolt-to-adult survival estimates from previous releases are presented in Table 16.

Adult Returns to the Umatilla River

The number of fall chinook salmon that returned to TMFD in 1996 was 1,332 fish (Appendix Table 8). Vital statistics on returns and run timing appear in Tables 17-18 and Figure 2. The first fish was trapped on 30 August 1996 and subjacks (52) peaked on 9 September, while jack (6) and adult (59) returns peaked on 11 and 12 October, respectively. The last fish was collected on 12 January 1997. The run consisted of 154 coded wire-tagged fish and 9 of these were strays. All strays originated from Lyons Ferry Hatchery (3 subjacks and 6 adults).

Table 13. Mean length, weight, and condition factor for yearling fall chinook salmon reared in Michigan or Oregon passes at Umatilla and Little White Salmon hatcheries in 1996-97.

Sample	Pass	Length(mm)		Weight(g)		Condition Factor	
		N	Mean(SE)	N	Mean(SE)	N	Mean(SE)
Umatilla Hatchery Oregon							
Jul:	A	114	71.2(0.4)	65	3.8(0.08)	65	1.06(0.01)
	B	104	70.9(0.5)	86	4.1(0.11)	86	1.15(0.05)
Aug:	A	102	92.0(0.52)	49	9.1(0.26)	49	1.14(0.01)
	B	99	92.8(0.52)	57	9.2(0.22)	57	1.15(0.01)
Sep:	A	103	104.7(0.7)	47	12.2(0.4)	47	1.10(0.01)
	B	100	107.2(0.7)	52	14.1(0.4)	52	1.11(0.01)
Oct:	A	103	116.2(0.9)	53	18.4(0.4)	53	1.14(0.01)
	B	98	120.1(1.0)	59	21.3(0.4)	59	1.17(0.01)
Nov:	A	172	134.7(1.2)	55	28.9(1.2)	55	1.14(0.01)
	B	169	137.9(1.0)	54	30.4(1.2)	54	1.16(0.01)
Dec:	A	89	153.1(1.3)	58	39.6(1.5)	58	1.09(0.01)
	B	120	151.3(1.4)	49	40.8(1.3)	49	1.10(0.01)
Jan:	A	104	170.3(1.5)	53	57.3(1.9)	53	1.09(0.01)
	B	110	174.5(1.3)	49	58.8(1.7)	49	1.10(0.01)
Pre-release: (17 Feb 97)	A	303	166.7(1.1)	101	55.2(1.9)	101	1.13(0.01)
	B	324	170.2(1.0)	109	56.9(1.4)	109	1.13(0.01)
Release ^a : (25 Mar 97)	A		172.3		58.4		1.14
	B		174.2		59.5		1.12
Michigan							
Jul:	A	103	72.4(0.4)	103	4.6(0.7)	103	1.19(0.01)
	B	112	71.3(0.4)	63	4.3(0.1)	63	1.16(0.01)
	C	108	70.5(0.5)	88	3.9(0.1)	88	1.10(0.02)
Aug:	A	114	90.8(0.5)	56	8.3(0.2)	56	1.11(0.01)
	B	106	89.8(0.5)	77	8.4(0.2)	77	1.15(0.01)
	C	122	89.5(0.6)	61	8.1(0.2)	61	1.13(0.01)

Table 13 (continued)

Sample	Pass	Length(mm)		Weight(g)		Condition Factor	
		N	Mean(SE)	N	Mean(SE)	N	Mean(SE)
Sep:	A	103	103.8(0.8)	52	12.9(0.4)	52	1.15(0.01)
	B	155	103.9(0.7)	57	13.1(0.5)	57	1.13(0.01)
	C	104	100.7(0.9)	104	12.0(0.4)	104	1.15(0.01)
Oct:	A	103	119.9(0.9)	60	21.0(0.6)	60	1.17(0.01)
	B	103	122.2(0.9)	55	21.9(0.7)	55	1.16(0.01)
	C	103	118.0(1.2)	52	20.0(0.9)	52	1.18(0.01)
Nov:	A	154	131.4(1.2)	49	27.7(1.2)	49	1.13(0.02)
	B	155	32.2(1.2)	60	32.2(1.4)	60	1.12(0.01)
	C	159	134.0(1.3)	52	34.3(1.7)	52	1.18(0.01)
Dec:	A	108	151.0(1.7)	51	43.3(2.1)	51	1.20(0.01)
	B	112	151.2(1.4)	52	43.8(1.6)	52	1.16(0.01)
	C	109	149.3(1.6)	63	41.1(1.6)	63	1.14(0.01)
Jan:	A	106	166.0(1.7)	56	49.9(1.7)	56	1.07(0.01)
	B	102	169.0(1.8)	53	59.1(2.6)	53	1.16(0.01)
	C	97	165.0(2.0)	51	56.3(2.1)	51	1.12(0.01)
Pre-release: (17 Feb 97)	A	316	173.4(1.0)	125	60.5(1.7)	125	1.14(0.01)
	B	303	177.0(0.9)	100	62.7(1.6)	100	1.11(0.01)
	C	311	166.9(1.1)	105	52.3(1.6)	105	1.03(0.01)
Release ^a : (25 Mar 97)	A		169.7		54.7		1.12
	B		175.6		57.4		1.06
	C		166.9		53.6		1.15

Little White Salmon Hatchery

Pre-release:	45	304	142.5(0.9)	115	33.0(1.0)	115	1.11(0.01)
(28 Mar 97)	46	299	143.1(0.8)	98	34.0(1.0)	98	1.11(0.01)

Release^b:

^a Release length was calculated from approximately 1200 fish; weight and condition factor from approximately 400 fish released on 18 April 1997.

^b No release data was calculated. Because of pump failure, fish were released on 30 Mar 97.

Table 14. Percent of descaled, partially descaled, and undamaged yearling fall chinook salmon reared at Umatilla and Little White Salmon hatcheries and released in 1997, 1995 brood.

System	Pass or Pond	Descaled ^a	Partially descaled ^b	Undamaged ^c
Umatilla Hatchery				
Michigan	A	8.7	56.5	34.8
Michigan	B	6.4	65.0	28.6
Michigan	C	3.9	37.9	58.3
Oregon	A	1.5	10.4	88.1
Oregon	B	0.0	12.1	87.9
Little White Salmon Hatchery				
Oregon	45	6.1	18.2	75.7
Oregon	46	3.0	9.5	87.6

^a *More than 0.20 descaling on either side of the fish.*

^b *Descaling = 0.03 to 0.20 on either side of the fish.*

^c *Less than 0.03 descaling on either side of the fish.*

Table 15. Coded-wire tag and paint mark information for yearling fall chinook salmon marked at Umatilla and Little White Salmon Hatcheries and released in 1997, 1995 brood (CWT = coded-wire-tag, AD = adipose fin, RV = right ventral fin).

Raceway	CWT code	Number CWT ^a	Paint mark		Fin Location	Fin clip	Number released
			Number	Color ^b			
Umatilla Hatchery							
M1A	091358	25,983	4,180	Red	Anal	RV/ADRV	51,112
M1B	091807	25,258				RV/ADRV	51,066
M1C	091359	25,232				RV/ADRV	50,865
O3A	091729	25,250	4,798	Orange	Anal	RV/ADRV	53,993
O3B	091748	25,260				RV/ADRV	51,917
Little White Salmon Hatchery							
45	070953	29,983				RV/ADRV	169,478
46	070954	30,344				RV/ADRV	91,490

^a Number recognizably CWT and released. All CWT fish were adipose fin clipped. All fish were right ventral fin clipped and all non-CWT fish were marked with a blank-wire tag.

^b Red paint mark represents codes 091729, 071359, and 091807. Orange paint mark represents codes 091729 and 191748..

Table 16. Exploitation and survival of yearling fall chinook salmon reared at Umatilla and Bonneville hatcheries, coded-wire-tagged (CWT), and released in the Umatilla River, 1990-94 brood years. Recoveries include age 3 and older fish and are incomplete for all brood years. Estimates of number of jacks and adults recovered are based on total production in each raceway. Data was downloaded in September 1997..

Brood year, CWT code	Raceway	N ^{a b}	Total exploit- ation rate (%)	Umatilla return rate (% of release)	Total survival rate (% of release)	Number of jacks and adults recovered
Umatilla Hatchery						
1994						
071039	M3A	0	0.00	0.00	0.00	0
071040	M3B	0	0.00	0.00	0.00	0
071041	M3C	0	0.00	0.00	0.00	0
Total		0				0
Bonneville Hatchery						
1990						
075618	A8	0	0.00	0.00	0.00	0
075619	A9	0	0.00	0.00	0.00	0
Total		0	0.00	0.00	0.00	0
1991						
071460	A5	5	60.0	0.01	0.02	14
071461	A6	9	55.6	0.02	0.04	26
Total		14	57.1	0.01	0.03	40
1992						
070252	A5	3	00.0	0.01	0.01	6
070255	A6	25	44.0	0.06	0.11	246
Total		28	39.3	0.04	0.06	252
1993						
070658	A2	4	0.00	0.02	0.02	18
070659	A6	0	0.00	0.00	0.00	0
Total		4	0.00	0.01	0.01	18
1994						
071037	A4	0	0.00	0.00	0.00	0
071038	A3	0	0.00	0.00	0.00	0
Total		0	0.00	0.00	0.00	0

^a Expanded CWT recoveries

^b Additional recoveries of age two subjacks (<381 mm FL) for each tag code were: 071460 - 3, 071461 - 3, 070252 - 15, 070255 - 33, 070658 - 47, 070659 - 27, 071037 - 45, 071038 - 17, -71039 - 1, 071040 - 5, 071041 - 10.

Table 17. Vital statistics for fall chinook salmon that returned to the eastbank fish ladder, Three-Mile Falls Dam, Umatilla River, 1996.

Age ^a	Number		Number		Number		Total	%
	male	%	female	%	unknown	%		
Subjack	606	100.0	0	0.0	0	0.0	606	45.5
Jack	80	100.0	0	0.7	0	0.0	80	6.0
Adult	357	55.3	289	44.7	0	0.0	646	48.5
Total	1043	78.3	289	21.7	0	0.0	1332	100.0

^a Age designation based on fork length: subjacks <381 mm, jacks 382-610 mm, adults >610 mm.

Table 18. Vital statistics by release strategy of fall chinook salmon that returned to the eastbank fish ladder in 1996, Three-Mile Falls Dam, Umatilla River. Data was determined from CWT recovery (sex was determined visually, all age 2 fish were assumed to be male).

Brood year	Age	Number	Sex	Fork length (mm)		
				mean	min	max
Subyearling						
1992	5	2	male	1020	985	1055
	5	4	female	847	768	885
1993	4	5	male	799	735	880
1992	4	7	female	818	775	875
1994	3	1	male	700		
1995	2	9	male	426	385	485
Yearling						
Umatilla Hatchery						
1994	3	1	male	490		
1995	2	91	male	373	305	460
Bonneville Hatchery						
1992	5	1	male	843		
1993	4	2	male	650		
1994	3	2	male	535	530	540

Fishery

Catch and harvest data from the fall chinook and coho salmon sport fishery is provided in Tables 19-20. Most anglers resided in Umatilla and Morrow counties (96.5%) with 2.1% from other Oregon counties, and 1.4% from out of state. Nine CWT fish were observed in the fishery, all were subjacks. Expanded CWT estimates by code were: 071037 (4), 071038 (8), 071039 (1), 071040 (4), and 071041 (4). No CWT coho were sampled in the fishery.

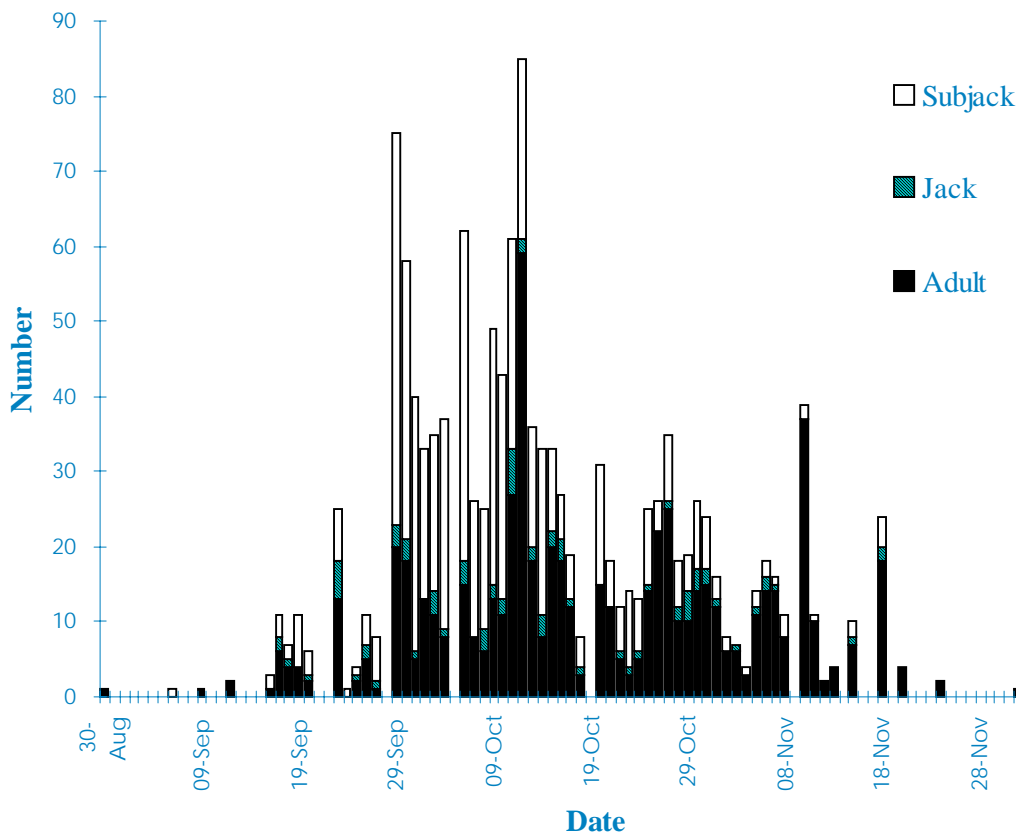


Figure 2. Numbers of subjack, jack, and adult fall chinook salmon counted at the east-bank fish ladder, Three Mile Falls Dam, Umatilla River, 1996 (subjack <381 mm, jack 382-610 mm, adult >610 mm, fork length).

Straying

Seven fall chinook salmon that were CWT and released in the Umatilla River were recovered at Lower Granite Dam (LGD) in 1996. Based on tagged to untagged ratios, Mendel (1997) estimated that 50 Umatilla fish arrived at LGD. Of these, 45 fish identified by tag or fin clip were removed, thus a total of 5 fish escaped past LGD. Using CWT data, the percentage recovery of Umatilla strays by brood year was: 5% (1990), 7% (1991), 20% (1992), 68% (1993). All Umatilla strays were from subyearling releases except the 1992 brood which was a yearling release. An additional 25 Umatilla strays (marked) were collected at Lyons Ferry Hatchery.

Table 19. Estimated catch statistics for fall chinook and coho salmon in the lower Umatilla River from the mouth to Three Mile Falls Dam in 1996. Number caught and number harvested includes \pm 95% confidence interval.

Fall Chinook Salmon									
				Adult Salmon ^a			Jack Salmon		
Month, Day type	Number days	Sampled anglers	Hours fished	Number caught	Number harvested ^a	Catch rate fish/h	Number caught	Number harvested	Catch rate (fish/h)
September									
Weekday	8	30	426	7±11	7±11	0.02	29±46	19±31	0.07
Weekend	9	78	461	4± 3	4± 3	0.01	47±38	40±33	0.10
Total	17	108	887	10±11	10±11	0.01	76±60	59±45	0.09
October									
Weekday	11	124	1023	±18	0± 0	0.02	76±41	67±38	0.07
Weekend	9	187	716	6 ± 1	4± 2	0.01	33±14	32±13	0.05
Total	20	311	1739	24±18	4± 2	0.01	109±43	99±40	0.06
November									
Weekday	10	67	460	8 ± 9	0± 0	0.02	15±24	0± 0	0.03
Weekend	11	179	703	20±27	0± 0	0.03	27±13	5± 6	0.04
Total	21	246	1163	28±28	0± 0	0.03	42±27	5± 6	0.04
Grand total	58	665	3789	62±35	14±11	0.02	227±79	162±61	0.06

Coho Salmon									
				Adult Salmon			Jack Salmon		
Month, Day type	Number days	Sampled anglers	Hours fished	Number caught	Number harvested	Catch rate fish/h	Number caught	Number harvested	Catch rate (fish/h)
September									
Weekday	8	30	426	17±24	17±24	0.04	42±46	42±46	0.10
Weekend	9	78	421	7±19	7±19	0.01	5± 4	5± 4	0.01
Total	17	108	887	24±30	24±30	0.02	47±46	47±46	0.03
October									
Weekday	11	124	1023	4±11	4±11	0.00	4± 8	4± 8	0.00
Weekend	9	187	716	15±27	15±27	0.02	0± 0	0± 0	0.00
Total	20	311	1739	19±29	19±29	0.01	4± 8	0± 8	0.00
November									
Weekday	10	67	460	0± 0	0± 0	0.00	0± 0	0± 0	0.00
Weekend	11	179	703	2± 2	2± 0	0.00	0± 0	0± 0	0.00
Total	21	246	1163	2± 0	2± 0	0.00	0± 0	0± 0	0.00
Grand Total	58	665	3789	44±42	44±42	0.01	51±47	51±47	0.01

^a Harvest of adult fall chinook salmon was legal below Highway 730.

Table 20. Number of fall chinook salmon planned for release in the Umatilla River and predicted escapement of returning adults above Lower Granite Dam using a model developed by the Oregon Department of Fish and Wildlife and a model developed by the National Marine Fisheries Service.

Oregon Department of Fish and Wildlife model

Group	Juveniles released in the Umatilla River	Strays above Lower Granite Dam		
		Low	Mean	High
Subyearlings	2,682,000	1	16	48
Yearlings	450,000	0	3	10
Total	3,032,000	1	19	58

National Marine Fisheries Service model

Return year	Stray fish to Lower Granite Dam		Strays above Lower Granite Dam			Juveniles released in the Umatilla River	
	Umatilla	Other	Umatilla	Other	Total	Number	Years
1992	41	2	4	2	6	3,450,000	1988-1991
1993	195	10	20	10	30	3,430,000	1989-1992
1994	268	18	27	18	45	3,279,000	1990-1993
1995	285	114	29	114	143	3,201,000	1991-1994
1996	50	213	5	200	205	3,079,412	1992-1995
Average	225	89	20	86	106	3,247,353	1989-1995

Table 21. Summary of fall chinook and coho salmon catch statistics (jacks and adults), Umatilla mouth to Three Mile Falls Dam, 1992-96.

Year	Sampled anglers	Hours fished	Chinook salmon			Coho salmon		
			Number caught	Number harvested	Catch rate (fish/h)	Number caught	Number harvested	Catch rate (fish/h)
1992	562	2,210	148	41	0.12	132	105	0.04
1993	639	1,666	15	9	0.01	53	53	0.02
1994	596	2,898	250	73	0.09	75	33	0.03
1995	517	2,201	120	46	0.03	55	48	0.01
1996	665	3,789	289	176	0.08	95	95	0.03

Using 1996 data we updated two models to estimate future numbers of strays that would escape past LGD. Both ODFW and NMFS models estimated that 19-20 fall chinook salmon of Umatilla origin would escape past LGD in future years (Table 21).

Discussion

Subyearlings, rearing in Michigan and Oregon raceways

Recovery of CWTs from the 1991 brood is complete, however, few tags were recovered. Recoveries from the 1992 and 1993 broods have been greater, and when complete may not provide adequate sample sizes (N=35) to perform statistical comparisons. Small sample sizes are probably related to poor survival. We recommend increasing the number of CWT per group to 60,000. Total survival for the 1991 (0.001%) and 1992 broods (0.025%) was considerably less than the master plan goal of 0.3%. Limited CWT data suggests similar survival rates for fish reared in MI or OR raceways and among fish reared in different MI passes. Preliminary exploitation estimates for the 1992 brood (43%) are less than master plan estimates (80%).

Subyearlings, density studies in Michigan raceways

Subyearlings were successfully reared at three densities at UFH in 1997. We found that water quality parameters were similar for all Michigan raceway and pass combinations. Measures of growth and condition were similar for all raceways despite differences in density and loading. However, reduced descaling at 200,000 fish per raceway (lowest density) suggests health benefits from rearing at low densities compared to rearing at standard and high densities. Final conclusions can only be determined when adult recovery data is evaluated.

We found similar survival to eye for embryos between stocks incubated at different temperatures at UFH except for one family group with low survival. In this study incubation temperatures were within tolerance ranges for chinook salmon. It has been well documented that lowering incubation temperatures during embryo development will delay and increase size at hatch. Prolonging embryo development and delaying hatch is preferred for standardizing hatch date or reducing feeding rates when size at release goals are reduced. Although the effect of temperature during embryo development on optimum growth from swim-up to juvenile release is unknown, our data suggests that early juvenile growth is not affected. More data concerning embryo development on later growth and sexual maturity is needed.

Painting the anal fin appeared to be an efficient method for marking. After a short period of training, personnel marked approximately 450 fish/h. In addition, by wearing proper safety equipment, the application of paint was safer than the use of liquid nitrogen for branding. The percentage of readable paint marks was similar to what we have observed in the past for brands as was the number of marked fish observed at John Day dam. Approximately 10,000 subyearlings were marked per liter of paint (\$0.08/fish, excluding initial start-up and personnel costs). These costs could be reduced significantly if an alternative paint source can be found. The use of this technique is an alternative to branding and PIT tags.

Although few paint marked fish were recovered at John Day dam, recovery data indicated that juvenile chinook salmon migrated rapidly. The last fish was recovered on 16 June; however, data from the Umatilla River (Knapp et al. in press) indicated only 74% of the run passed Three Mile Falls Dam by 10 June. Low recovery rates may be caused by poor juvenile survival or poor trapping efficiency.

The number fish that are CWT needs to be increased. Recent smolt-to-adult survival of subyearlings has been poor (see rearing in MI & OR raceways). Although the number tagged (30,000) was double the expected number needed to obtain 35 observed recoveries per group, total survival has been much poorer than expected. We recommend increasing number tagged from 30,000 to 60,000-90,000 per group to obtain adequate sample sizes for the density study.

Effects of Tagging and Marking:

Analysis for all broods has been hindered by low recovery rates, difficulties in determining the presence or absence of body-tags, and experimental design. Data for the 1990 brood tagged at Irrigon Hatchery is complete and suggests that survival of body-tagged fish was similar to other groups. Lowest survival was found for a group that was double fin-clipped (AD+CWT+RV). Analysis will not be completed for the 1991 brood because of small sample sizes. Preliminary data for the 1992 brood suggests similar survival for all groups.

Yearlings

Yearling fall chinook salmon were reared for the second time at UFH in 1996-97. Few differences in water quality parameters were observed for fish reared in MI and OR raceways, or within OR passes. Mean length, weight, and condition factor were similar for fish reared in each system. However, descaling was greater for fish reared in MI raceways. Fish reared in OR raceways at UFH and LWSH had similar descaling.

Recent recovery data suggests poor survival for yearlings released in the Umatilla River. No CWTs have been recovered from the 1990 brood. Incomplete recovery data from the 1991-1993 broods suggests greater survival, but it is unlikely the 0.75% return goal will be reached. If there is a positive relationship between survival of subjacks and adult survival, fish reared at BFH should exceed the survival of fish reared at UFH. Returns of age 2 chinook in 1996 averaged 31 per code for those reared at BFH compared to 5 per code for fish reared at UFH.

Adult Returns to the Umatilla River

The number of adult fall chinook salmon counted at TMFD was 646, the second greatest on record. The remainder of the run was composed of subjacks (606) and jacks (80). Both subyearling (79%) and yearling (21%) release strategies contributed to the age 3+ adult returns in 1996. All age 2 fish recovered in 1996 were from yearling releases and 90% were subjacks by length. Subjacks continue to constitute a large percentage of the total run and represent lost adult production. These fish are usually all males and return to TMFD the same year they were released.

The relationship between rearing temperature, growth rates, and size-at-release for yearlings released in the Umatilla River is unclear. It has been suggested that the decision to mature is made early during rearing. Rearing temperatures and growth patterns at UFH and BFH are different, yet both hatcheries contribute subjacks. No direct relationship between mean size-at-release and number of subjacks produced is apparent although release size has varied from 5.1-10.4 fish/lb. Fish reared at LWSH and

released at 13.6 fish/lb may provide information on the relationship between size at release and the production of subjacks.

Fishery

Total fishing effort for fall chinook and coho salmon in 1996 (3,789 h) was greater than previous years (Table 21). Catch rates (0.08 and 0.03 fish/h) for jack and adult chinook and coho salmon were within the range of previously reported values (Table 21.). Harvest estimates below TMFD represented 20% and 13% of the total 1996 fall chinook and coho salmon runs (jacks and adults).

Straying

Wire tagging and the ability to remove adults at Lower Granite Dam appears to be reducing the escapement of strays. Fifty fish arrived at the dam in 1996, but only 5 passed the dam because most wire-tagged fish were removed. As in recent years, most strays in 1996 originated from subyearling releases. The estimate of 50 fish arriving at the dam was lower than in recent years and may be related to improved attraction flows at the mouth of the Umatilla River in the fall or poor survival. Beginning in 1993 flows at the mouth of the Umatilla River were nearly 100 ft³/s compared to <20 ft³/s in prior years. This relationship cannot be evaluated until complete brood year data is available.

SPRING CHINOOK SALMON

Overview

To restore spring chinook salmon to the Umatilla River, three rearing and release strategies have been used at UFH. Subyearlings were reared (1991-93 broods) because of the growth potential created by using warm water. Fish were also released in the fall (1991-93 broods) because additional rearing space was available and fall releases had shown some success in the Willamette River. Four yearling broods (1991-95) have been reared at UFH. The yearling release strategy is considered experimental because eggs must be chilled for an extensive period to before rearing to produce smolts at 10 fish/lb for spring release.

Methods

Subyearlings

Juvenile Rearing and Survival Studies: No subyearlings were reared in 1997. Methods were described in previous annual reports.

Adult Survival Studies: Methods to determine smolt-to-adult survival were the same as described for fall chinook salmon.

Fall Release

Juvenile Rearing and Survival Studies: No fish for fall release were reared in 1996-97. Methods used were described in previous annual reports.

Adult Survival Studies: Methods to determine smolt-to-adult survival were the same as described for fall chinook salmon.

Yearlings

Juvenile Rearing and Survival Studies: Methods in rearing and survival studies were the same as described for subyearling fall chinook salmon. Methods to paint mark smolts were the same as described for subyearling fall chinook salmon except that fish were marked at acclimation facilities on the Umatilla River.

Adult Survival Studies: Methods to determine smolt-to-adult survival were the same as described for fall chinook salmon.

Adult Returns to the Umatilla River

Methods used to collect data on spring chinook salmon returns and survival estimates were the same as described for fall chinook salmon. We also tested photonic paint marks to identify spring chinook salmon broodstock (1997 brood). Adults were marked during anesthetization for health treatments at the South Fork Walla-Walla broodstock facility. Each fish was marked at the base of the dorsal fin, base of the pectoral fin, on the pectoral fin ray, and on the anal fin ray. In addition, the opercle of each fish was punched to provide a double mark. After marking, adults were returned to raceways. Each fish was examined during spawning (August-September) for mark retention.

Fishery

Except for the following modifications, methods to survey the spring chinook salmon fishery in 1997 were described in the 1993 annual report (Keefe et al. 1994). The spring chinook salmon sport fishery was open from 17 May to 8 June and from 21 June to 20 July 1997. Fishing was allowed between TMFD and the Highway 11 bridge in Pendleton. Regulations allowed anglers to harvest one jack (15-24 in) or adult salmon (>24 in) daily. To survey the fishery we divided the area into two reaches: 1) TMFD to the Yoakum bridge, and 2) Yoakum bridge to Highway 11 bridge. Sample days were divided into weekday and weekend strata and angler counts were made during early shifts (0500, 0830, 1130 h) or late shifts (1300, 1630, and 2000 h). Anglers were interviewed between effort counts and additional interviews were made during effort counts when possible. Average daily effort was estimated by calculating the average effort for all daily count periods and multiplying this value by the available fishing hours. Total effort was estimated by multiplying average daily effort by the number of days in each strata. Harvest was calculated by multiplying the mean catch rate times the estimate of total effort. We adjusted harvest and effort estimates to correct for trout and other anglers that were fishing during the salmon season.

Statistical Analyses

Methods used to analyze data were the same as those used for fall chinook salmon.

Results

Subyearlings

Overview: One brood (1991) of subyearling spring chinook salmon was reared in OR raceways and three broods (1991-93) were reared in MI raceways at UFH and released in the Umatilla River (Appendix Table 4). The objectives of this study were to evaluate the subyearling rearing strategy and to compare rearing conditions, migration, cost, and smolt-to-adult survival between subyearlings produced in MI and OR systems and among passes within MI system. Adult returns will be completed in 1999.

Juvenile Rearing and Survival Studies: No subyearlings were reared at UFH in 1997. Juvenile data at pre-release and release were presented in earlier annual reports (Keefe et al. 1993 and 1994)

Adult Survival Studies: Coded-wire tag recovery data is incomplete. Since only one CWT fish has been recovered there has been no MI versus OR system or MI pass comparison.

Fall Release

Overview: Two broods (1992 and 1993) were reared in MI raceways and three broods (1991-93) were reared in OR raceways at UFH and released in the fall (Appendix Table 5). One brood (1991) was reared at BFH (Appendix Table 5). The objectives of this study were to compare rearing conditions, migration, cost, and smolt-to-adult survival for fish produced in MI and OR systems and among passes within the MI system. Comparisons will be made between fish reared in OR raceways at UFH and OR raceways at BFH. Completed adult returns will be available in 2002.

Juvenile Rearing and Survival Studies: No fish from the 1996 brood were reared for release in 1997. Smolt condition and survival from previous releases were presented in Keefe et al. 1993, 1994, and 1995.

Adult Survival Studies: Recovery data of previously released CWT groups is presented in Table 22. Estimated survival of CWT jacks and adults from the 1991 brood were poorer than BFH releases. Survival of CWT groups reared in MI and OR raceways were similar.

Yearlings

Overview: Two broods reared in MI raceways (1993-94) and 5 broods (1991-95) in OR raceways have been reared at UFH (Appendix Table 6). Three broods (1991-93) have also been reared at BFH (Appendix Table 6). The objectives of this study are to compare rearing conditions, migration, cost, and smolt-to-adult survival for yearlings produced in MI and OR raceways at UFH and in OR raceways at BFH. Fish reared at UFH are chilled as eggs to meet size-at-release goals. In addition, rearing temperatures at UFH are greater (50-55 °F) than recommended for spring chinook salmon. Completed adults returns will be available in 2002.

Umatilla Hatchery:

Juvenile Rearing and Survival Studies: Data on juvenile rearing and releases is presented in Tables 23-26 and Appendix Table 5. Yearlings were ponded in one OR raceway on 26 April 1996 at 754 fish/lb. In August they were marked and split into four OR raceways at 32 to 35 fish/lb. Food conversion ratios ranged from 1.10 to 1.21 in OR raceways. Oregon raceways produced an average of 90 fish/gpm. Rearing costs were \$0.57 per fish including marking costs and \$0.53 per fish when marking costs were not included.

Table 22. Exploitation and survival of spring chinook salmon released in the fall that were coded-wire-tagged (CWT) and released in the Umatilla River, 1990-93 brood years. Recoveries include age 3 and older fish. All brood years are incomplete. Estimates of number of jacks and adults recovered are based on total production in each raceway.

Brood year, CWT code	Raceway	N ^a	Total exploit- tation rate (%)	Umatilla return rate (% of release)	Total survival rate(% of release)	Number of jacks and adults recovered
Umatilla Hatchery						
1991						
071542	O3B	0	0.00	0.00	0.00	0
071543	O3A	3	0.00	0.01	0.01	6
		3				6
1992						
070155	O2A	3	0.00	0.01	0.01	3
070156	O3B	0	0.00	0.00	0.00	0
070157	O2B	0	0.00	0.00	0.00	0
070158	O3B	3	0.00	0.01	0.01	4
070159	M2A	3	0.00	0.01	0.01	4
070160	M3A	5	0.00	0.01	0.01	7
070161	M2B	0	0.00	0.00	0.00	0
070162	M3B	9	0.00	0.03	0.03	12
070163	M3C	1	0.00	0.00	0.00	1
070216	M2C	4	0.00	0.01	0.01	5
		28				36
1993						
070724	M2C	18	0.00	0.05	0.05	21
070725	M3C	16	0.00	0.05	0.05	18
070726	M2B	20	0.00	0.06	0.06	23
070727	M3B	9	0.00	0.02	0.03	10
070728	M2A	7	0.00	0.02	0.02	8
070729	M3A	14	0.00	0.03	0.04	16
070730	O2A	21	0.00	0.06	0.06	22
070731	O1A	29	0.00	0.08	0.08	30
070732	O2B	17	0.00	0.05	0.05	17
070733	O1B	22	0.00	0.06	0.06	22
		157				187

Table 22. (continued)

Brood year, CWT code	Raceway	N ^a	Total exploit- tation rate (%)	Umatilla return rate (% of release)	Total survival rate(% of release)	Number of jacks and adults recovered
Bonneville Hatchery						
1991						
076042	A11	6	0.00	0.02	0.02	6
076043	A10/A11	9	0.00	0.04	0.04	9
076044	A10	2	0.00	0.01	0.01	2
076045	A9	8	0.00	0.03	0.03	8
076046	A8/A9	8	0.00	0.03	0.03	8
076047	A8	3	0.00	0.02	0.02	3
		36				36

Table 23. Egg-take and survival of yearling spring chinook salmon reared at Umatilla Hatchery, brood years 1991-95. All eggs are Carson stock.

Egg source	Brood year	Release Strategy	Number of eggs taken or received	Egg-to-fry survival (%)	Egg-to-smolt ^a survival (%)
Carson NFH	1991	Yearling	332,000	97.2	93.4
Carson NFH	1992	Yearling	319,000	71.3	67.4
Carson NFH	1993	Yearling	314,000	66.6	61.8
Ringold/Lyons Ferry	1994	Yearling	602,000	71.8	58.8
Carson Lyons Ferry/Little White Salmon	1995	Yearling	226,600	96.3	99.7

^a Survival is based on green egg-to-smolt stage.

Table 24. Rearing conditions immediately before transfer for yearling spring chinook salmon in Michigan or Oregon raceways at Umatilla and Bonneville hatcheries, brood years 1991-1995.

Brood year	System	Maximum density (lb/ft ³)	Maximum loading (lb/gal/min)
Umatilla Hatchery			
1991	Oregon	1.0	5.0
1993	Oregon	0.9-1.1	4.6-5.4
1994	Michigan	2.4-2.7	5.9-6.6
	Oregon	1.2-1.3	5.6-6.2
1995	Oregon	1.0	4.8-4.9
Bonneville Hatchery			
1991	Oregon	0.6-0.7	5.0-5.3
1992	Oregon	0.8-1.0	6.8-9.8
1993	Oregon	0.7-0.8	4.9-6.2

Table 25. Water quality measurements in Oregon passes used to rear yearling spring chinook salmon in 1996-97. Means are combined values for first and second pass raceways.

Parameter measured	Mean parameter value (N)			
	N	A pass	N	B pass
Sampling period	Jun 28-Jan 17		Jun 28-Jan 17	
Temperature head (°C)	39	13.5	30	13.6
Temperature tail (°C)	39	13.7	30	13.8
pH head	38	7.9	29	8.0
pH tail	38	7.9	29	7.9
Oxygen head (ppm)	38	10.4	29	9.8
Oxygen tail (ppm)	38	9.3	29	8.6
Nitrogen head (mmHg)	38	592	29	597
Nitrogen tail (mmHg)	38	605	29	613
Total pressure-head (mmHg)	38	749	29	747
Total pressure-tail (mmHg)	37	747	29	744
Unionized ammonia (µg/l)	19	0.15	19	0.15
Alkalinity (mg/l CaCO ₃)	20	132	20	132

Table 26. Mean length, weight, and condition factor for yearling spring chinook salmon reared in Oregon raceways at Umatilla Hatchery in 1996-97, 1995 brood.

Sample	Pass	Length(mm)		Weight(g)		Condition Factor	
		N	Mean(SE)	N	Mean(SE)	N	Mean(SE)
June:	A	110	79.1(0.4)	78	6.6(0.1)	78	1.30(0.01)
July:	A	310	104.9(0.5)	180	15.4(0.3)	180	1.34(0.01)
	B	358	103.1(0.5)	175	14.6(0.3)	175	1.30(0.01)
August:	A	210	110.1(0.4)	121	18.3(0.3)	121	1.39(0.01)
	B	232	108.9(0.4)	109	17.5(0.3)	109	1.35(0.01)
September:	A	202	123.9(0.5)	117	26.8(0.4)	117	1.40(0.01)
	B	202	122.7(0.6)	131	27.7(0.7)	131	1.44(0.01)
October:	A	209	134.4(0.7)	104	35.8(0.8)	104	1.45(0.01)
	B	206	134.2(0.8)	126	35.9(0.8)	126	1.48(0.01)
November:	A	209	140.8(0.8)	127	39.5(1.4)	127	1.37(0.01)
	B	193	140.7(0.9)	96	40.6(1.7)	96	1.37(0.01)
December:	A	193	150.1(0.9)	100	47.0(1.5)	100	1.35(0.01)
	B	227	151.0(0.8)	117	46.7(1.2)	117	1.34(0.01)
Pre-release:	A	621	148.2(0.5)	205	46.0(0.9)	205	1.37(0.01)
	B	631	150.2(0.5)	212	45.9(0.8)	212	1.35(0.01)
Release ^a :		677	160.7	432	49.9	432	1.21

^a Fish were sampled from two acclimation ponds on 12 March and 26 March, 1997.

Smolt condition at pre-release and release are presented in Tables 26-28. Oregon reared fish averaged 1.5% smolted and descaling was estimated at 86% undamaged. Fish were 99% recognizably ventral clipped.

Photonic marks, CWT, and production release data is presented in Table 29 and Appendix Table 5. Estimated passage of paint-marked fish at John Day Dam was 372 fish (10.0%) and 395 fish (10.6%) at Bonneville Dam. Fish were released on 26 March and detected at John Day Dam 21 to 46 days later. More than 50% of the fish had passed 40 days after release.

Adult Survival Studies: CWT recovery data is presented in Table 30.

Adult Returns to the Umatilla River

Vital statistics returns of spring chinook salmon to TMFD in 1996 and 1997 are presented in Tables 32-33. The 1997 run began on 11 April, peaked 11 May, and ended 13 September (Figure 3). It consisted of 2,192 adults, 4 jacks, and 2 mini jacks with a male to female ratio of 44:56 (Table 31). Natural or unmarked fish made up 8.1% of the run. Composition of adult returns by release strategy was BFH yearlings (67%), UFH fall releases (27%), and UFH yearlings (6%).

One hundred percent (N=30) of the paint marked adults were identified by the opercle mark and examined for mark quality. We found 70% of pectoral girdle marks were good and 30% were fair with no poor or unmarked fish observed. Application in the pelvic girdle was simple and did not require a high level of accuracy to produce a good mark. In contrast, we estimated that marks in the pectoral fin were 0% good, 27% fair, 30% poor, and 43% undetectable. It was difficult to consistently apply a good mark to the pectoral fin ray. Accuracy was important and the angle of application appeared to be crucial to injecting the paint into skin surrounding the fin ray. Fish marked at the base of the dorsal fin were 0% good, 10% fair, 27% poor, and 63% undetectable. Accuracy was also important at the base of the dorsal fin. Moving the mark only a small distance from the preferred location produced unacceptable marks. Yellow was more difficult to identify compared to other colors because it blended with the natural colors of the skin as the fish approached spawning and decaying proceeded. Detectable marks were retained for up to 56 d.

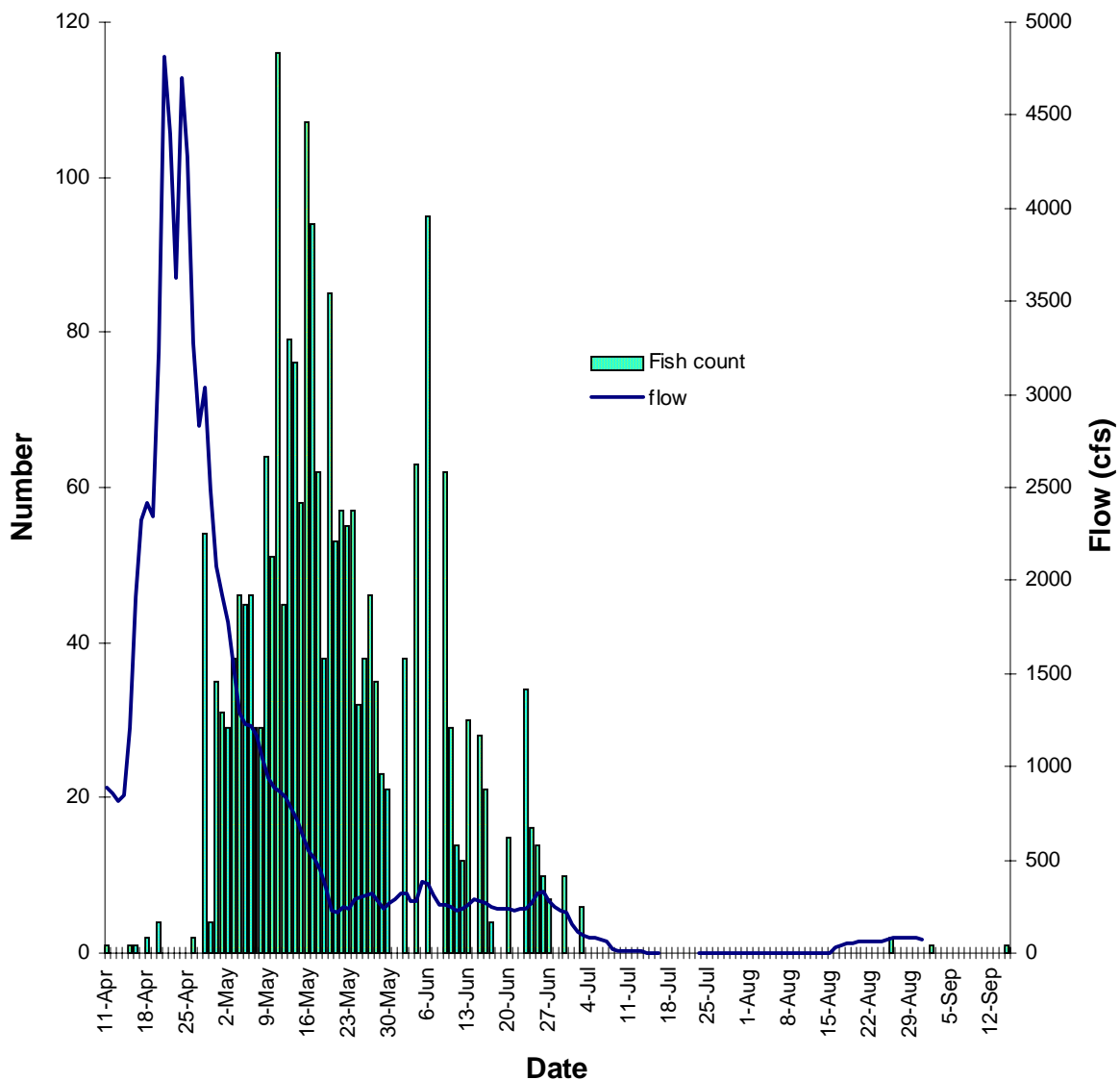


Figure 3. Counts of jack and adult spring chinook salmon at the east-bank fish ladder, Three Mile Falls Dam, Umatilla River plotted against Umatilla River flow at Umatilla, Oregon, 1997.

Fishery

Fishery data in 1997 is presented in Table 34. This was the first year the river from TMFD to Stanfield Dam was open to angling. Anglers in this reach fished one third as much as in the upper river, but had a higher catch rate. We estimated that anglers harvested 2.8% of the run. Most anglers (91.7%) were from Morrow and Umatilla counties, 5.7% were from other Oregon counties and 2.6% were from out of state.

Table 27. Mean length, weight, and condition factor at pre-release or release for yearling spring chinook salmon reared in Michigan or Oregon raceways at Umatilla Hatchery, 1991-95 broods (standard error in parentheses).

Brood year	System	Length (mm)	Weight (g)	Condition factor
1991	Oregon	158.8(0.0)	50.5(0.0)	1.20(0.0)
1992	Oregon	163.0(0.7)	55.2(1.3)	1.23(0.01)
1993 ^a	Michigan	166.9	57.8	1.24
	Oregon	171.0	56.9	1.16
1994 ^a	Michigan	160.9	46.4	1.11
	Oregon	167.7	53.0	1.12
1995 ^a	Oregon	149.2	45.9	1.35

^a Fish from the 1993 through 1995 brood years were measured at release after acclimation, standard errors were not available. Other brood years were not acclimated and were released directly into the Umatilla River.

Table 28 Mean proportion of descaled, partially descaled, and undamaged yearling spring chinook salmon reared in Michigan and Oregon raceways at Umatilla Hatchery, brood years 1991-95.

Brood year	System ^a	Descaled ^b	Partially descaled ^c	Undamaged ^d
1991	Oregon	0.01	0.01	0.99
1992	Oregon	0.01	0.18	0.81
1993	Michigan	0.03	0.24	0.74
	Oregon	0.00	0.15	0.85
1994	Michigan	0.13	0.54	0.33
	Oregon	0.01	0.12	0.87
1995	Oregon	0.01	0.13	0.86

^a Combined first and second pass raceways

^b More than 0.20 descaling on either side of the fish.

^c Descaling = 0.03 to 0.20 on either side of the fish.

^d Less than 0.03 descaling on either side of the fish.

Table 29. Coded-wire tag and photonic mark information for yearling spring chinook salmon reared at Umatilla Hatchery and released in 1997, 1995 brood (CWT = coded-wire-tag, AD = adipose fin, RV = right ventral fin).

Raceway	CWT code	Number CWT ^a	Photonic mark ^b			Fin clip	Number released
			Number	Color	Fin location		
O4A	091730	19,842	3,724	Green	Anal	ADRV	57,688
O4B	091750	20,289				ADRV	56,901
O5A	091749	19,818				ADRV	56,764
O5B	091751	20,597				ADRV	54,550

^a Number recognizably coded-wire-tagged and released. All CWT fish are also adipose fin clipped and all fish received a right ventral fin clip.

^b Photonic mark represents tag codes 091730, 091750, and 091751.

Table 30. Exploitation and survival of yearling spring chinook salmon that were coded-wire-tagged (CWT) and released in the Umatilla River, 1990-93 brood years. Recoveries include age 3 and older fish. All brood years are incomplete. Estimates of number of jacks and adults recovered are based on total production in each raceway.

Brood year, CWT code	Raceway	N ^a	Total exploit- ation rate (%)	Umatilla return rate (% of release)	Total survival rate(% of release)	Number of jacks and adults recovered
Umatilla Hatchery						
1991						
075739	O5B	3	0.00	0.01	0.01	7
075740	O4B	1	0.00	0.01	0.01	2
075741	O4A	6	0.00	0.03	0.03	15
075742	O5A	3	0.00	0.01	0.01	8
Total		13	0.00	0.02	0.02	32
1992						
070217	O5A	0	0.00	0.00	0.00	0
070218	O5B	14	0.00	0.07	0.07	35
070219	O4B	9	0.00	0.04	0.04	23
070220	O4A	23	0.00	0.11	0.11	57
Total		46	0.00	0.06	0.06	115

^a Expanded CWT recoveries

Table 30 (continued)

Brood year, CWT code	Raceway	N ^a	Total exploit- tation rate (%)	Umatilla return rate (% of release)	Total survival rate(% of release)	Number of jacks and adults recovered
1993						
071453	M5A	4	0.00	0.02	0.02	10
071454	M5B	7	0.00	0.04	0.04	18
070651	O4A	4	0.00	0.02	0.02	10
070652	O4B	6	0.00	0.03	0.03	14
070653	O5A	13	0.00	0.07	0.07	32
070654	O5B	1	0.00	0.01	0.01	3
Total		35	0.00	0.03	0.03	87
Bonneville Hatchery						
1991						
071455	1A	24	0.00	0.12	0.12	55
071456	2B	18	0.00	0.09	0.09	41
Total		42	0.00	0.11	0.11	96
1992						
070250	B6	142	0.00	0.53	0.53	529
070251	B5	129	0.78	0.49	0.49	499
075944	B8	109	0.91	0.54	0.55	569
075945	B7	80	0.00	0.40	0.40	394
Total		460	0.39	0.49	0.49	1,991
1993						
070649	B7	137	0.00	0.62	0.62	761
070650	B8	127	0.00	0.53	0.53	657
070660	B5	71	1.45	0.30	0.30	225
070661	B6	147	0.00	0.51	0.51	383
Total		482	0.36	0.49	0.49	2,026

Table 31. Statistics for spring chinook salmon that returned to the eastbank fish ladder, Three-Mile Falls Dam, Umatilla River, 1995-97.

Age ^a	Number		Number		Number		Total	%
	male	%	female	%	unknown	%		
1995								
Subjack	26	100.0	0	0.0	0	0.0	26	5.2
Jack	82	100.0	0	0.0	0	0.0	82	16.5
Adult	162	41.8	224	57.7	2	0.0	388	78.2
Total	270	54.4	224	45.2	2	0.4	496	100.0
1996								
Subjack	0	0.0	0	0.0	0	0.0	0	0.0
Jack	121	100.0	0	0.0	0	0.0	121	16.5
Adult	948	44.1	1204	55.9	0	0.0	2152	94.8
Total	1069	47.0	1204	53.0	0	0.0	2273	100.0
1997								
Subjack	0	0.0	0	0.0	0	0.0	2	0.0
Jack	4	100.0	0	0.0	0	0.0	4	00.0
Adult	968	44.2	1223	55.8	0	0.0	2192	00.0
Total	972	44.3	1223	55.6	1	0.1	2198	100.0

^a Age designation based on fork length: subjacks <381 mm, jacks 382-610 mm, adults >610 mm)

Table 32. Vital statistics of spring chinook salmon that returned to the Umatilla River in 1996 by release strategy and hatchery. Data was determined from CWT recovery (sex was determined visually, all age 2 fish were assumed to be male).

Hatchery brood	Age	Number	Sex	Fork length (mm)		
				mean	min	max
Fall release						
Umatilla Hatchery						
1991	5	1	male	1030		
1992	4	3	male	795	790	800
1992	4	4	female	781	755	830
1993	3	18	male	600	482	670
Bonneville Hatchery						
1991	5	1	male	1090		
1991	5	1	female	810		
Yearling						
Umatilla Hatchery						
1991	5	1	male	825		
1992	4	5	male	838	800	865
1992	4	6	female	783	740	830
Bonneville Hatchery						
1991	5	4	male	978	905	1040
1991	5	1	female	745		
1992	4	40	male	829	560	915
1992	4	65	female	769	700	840
1993	3	16	male	558	482	600

Table 33. Vital statistics of spring chinook salmon that returned to the Umatilla River in 1997 by release strategy and hatchery. Data was determined from CWT recovery (sex was determined visually, all age 2 fish were assumed to be male).

Hatchery brood	Age	Number	Sex	Fork length (mm)		
				mean	min	max
Subyearling						
Umatilla Hatchery						
1993	4	1	male	980		
Fall release						
Umatilla Hatchery						
1992	5	1	male	776		
1993	4	24	male	802	485	920
1993	4	34	female	791	730	862
Yearling						
Umatilla Hatchery						
1992	5	1	unknown	980		
1993	4	4	male	797	770	816
1993	4	8	female	770	735	808
1995	2	1	male	305		
Bonneville Hatchery						
1992	5	15	male	995	900	1115
1992	5	6	female	922	870	970
1993	4	87	male	818	650	900
1993	4	118	female	787	680	895

Table 34. Estimated catch statistics for spring chinook salmon in the Umatilla River in 1997. Lower river = Three Mile Falls Dam to Yoakum bridge. Upper River = Yoakum bridge to lower boundary of the Confederated Tribes of the Umatilla Indian Reservation.

Day type	<u>Number sampled</u>		Hours fished	Number caught	Number harvested	Catch rate (fish/h)
	days	anglers				
Lower River						
Weekday	6	46	629	19	19	0.031
Weekend	4	12	183	0	0	0.000
Total	10	58	812	19	19	0.023
Upper River						
Weekday	9	236	1251	5	5	0.004
Weekend	4	101	1077	7	7	0.005
Total	13	337	2328	12	12	0.005
Combined Total						
Weekday	15	282	1880	24	24	0.013
Weekend	8	113	1461	7	7	0.005
Total	23	395	3341	31	31	0.009

Table 35. Statistical summary of spring chinook salmon sport fishery, 1990-97. There was no sport fishery for missing years.

Year	Reach	Angling days	Number of anglers	Hours fished	Number caught and harvested	Run	Catch rate (fish/h)
1990	Ryan Creek to Forks	12	80	1248	20	2,190	0.02
1991	Ryan Creek to Forks	12	235	1544	23	1,330	0.01
1993	Stanfield Dam to CTUIR	16	39	317	0	1,221	0.00
	Ryan Creek to Forks		145	1,211	18		0.02
1996	Rieth Bridge to Hwy 11	20	428	2,471	205	2,273	0.08
	Ryan Creek to Forks		67	429	1		0.00
1997	Three Mile Dam to Yoakam Bridge	23	58	812	19	2,188	0.02
	Yoakam Bridge to Hwy 11		337	2,529	12		0.01

Discussion

Subyearlings

Smolt-to-adult survival of subyearling spring chinook salmon from UFH is below the 0.2% goal (CTUIR and ODFW 1990). Poor survival may have been caused by the small release size (25-30 fish/lb (Keefe et al. 1993, 1994 and Hayes et al. 1995, 1996). Since only one CWT fish has been recovered, comparisons of survival between MI or OR systems or among passes within the MI system cannot be completed. The management recommendation is to curtail this strategy unless water or eggs are in excess, size at release can be increased, or a different spring chinook salmon stock is available.

Fall Release

Smolt-to-adult survival for the fall release strategy is below the 0.4% goal (CTUIR and ODFW 1990). Adult survival of the 1991 brood (0.0-0.01%) reared at UFH was poorer than the 1991 brood reared at BFH (0.01-0.04%). Poor survival for 1991 and 1992 UFH broods may be size related. Fish reared at UFH were released at 19.4 fish/lb compared to 11.5 fish/lb for BFH fish. The 1993 brood was larger at release (9.3 fish/lb) and preliminary CWT recovery data suggests improved survival (0.02-0.10%) . Preliminary data from the 1993 brood indicates similar survival for fish reared in MI or OR raceways and among passes within the MI system. We recommend this strategy be further investigated at UFH.

Yearlings

Smolt-to-adult survival of yearlings from UFH is well below the 0.75% goal (CTUIR and ODFW 1990). Fish reared at BFH are five times more likely to survive and return as adults than UFH fish. If all releases experience the same river and ocean conditions, then increased survival of BFH fish is directly related to rearing profiles or fish health. Fish reared at BFH may be more fit or healthier. In comparison to fish reared at UFH, fish from BFH experience several months of coldwater rearing (<45°F) and are smaller at release. Management recommendations include, moving all yearling UFH spring chinook salmon production to another hatchery, changing UFH yearling production to fall release strategy or to acclimation facilities in the fall for rearing in cold water, reducing size at release and cost, or use of different stocks.

Adult Returns to the Umatilla River

Returns of jacks and adults (2,198) in 1997 was close to the expected run of 2,277 and the 1996 run of 2,273. The majority of the run was comprised of yearlings from BFH. If survival of fish reared at UFH had been similar to fish reared at BFH, the run would have approached 5,000 fish. From regression analyses of jack to adult relationships we predict a run of 509 fish (0-1,100 95% CI) in 1998.

Fishery

Sport fishing for spring chinook salmon in the Umatilla River has been opened for two consecutive years. In 1997 effort from Yoakum Bridge to Highway 11 was equal to effort in 1996 despite lower catch rates. The area from TMFD to Yoakam Bridge was opened to sport fishing for the first time in 1997. Angler effort in this reach was less than one-half (812 h) the effort in the upper area (2,529 h); however, angler success was similar (0.02 fish/h). Effort in both reaches was greater early in the season, but dropped quickly as anglers failed to catch fish. Reports from the tribal creel indicated that many fish were harvested within the CTUIR boundary (Contor, CTUIR personal communication). Sport anglers may have harvested more fish if the Ryan Creek to Forks reach had been opened in 1997 as in past years; however, we recommend that it remain closed. This area contains good spawning habitat and fish should not be removed or harassed after migrating to this reach. Managers may want to investigate opening the river below TMFD to angling to increase fishing opportunities. Opening this area may give anglers greater access to fish. The area below TMFD has bank and boat access and the fishery is more easily monitored than upstream areas. Fishing could be regulated weekly based on counts at TMFD.

SUMMER STEELHEAD

Overview

The objective of the steelhead rearing evaluation is to monitor rearing conditions, cost, migration, and smolt-to-adult survival for steelhead produced in the MI system and compare these parameters among MI passes. Six steelhead broods (1991-96) have been reared in MI raceways at UFH and released in the Umatilla River (Appendix Table 7). Comparisons are being made with Imnaha and Wallowa stock steelhead reared in OR raceways at Irrigon Fish Hatchery. The original production goal of 210,000 fish was reduced to 150,000 fish after the first year (1991) because high densities appeared to cause poor fish condition. Adult returns will be complete in 2001.

Methods

Juvenile Rearing and Survival Studies

Methods to study juvenile rearing and survival were the same as described for subyearling fall chinook salmon.

Adult Survival Studies

Methods to collect data on steelhead returns and survival estimates were the same as described for fall chinook salmon. Data for steelhead was downloaded from the PSMFC database in September 1997.

Adult Returns to the Umatilla River

Methods to calculate adult returns were the same as described for subyearling fall chinook salmon.

Fishery

Except for the following modifications, methods to survey the steelhead sport fishery in 1996-97 were described in previous annual reports. The steelhead fishery was open from 1 September 1996 to 15 April 1997. Twenty of the scheduled creel days were not sampled because of flooding and were considered to be zero effort and zero catch. Angling was allowed from the Highway 730 bridge in Umatilla to the lower CTUIR boundary upstream of Pendleton. Rainbow trout over 20 inches in length were considered steelhead. The legal harvest limit was 2 adipose-clipped steelhead per day and 20 for the season. Only barbless hooks could be used from 1 September to 31 December; beginning 1 January 1997 barbed hooks were legal.

Statistical Analyses

Methods to analyze data were the same as those used for fall chinook salmon.

Results

Juvenile Rearing and Survival Studies

Data on juvenile rearing and survival is presented in Tables 36-41 and Appendix Tables 1 and 7. Steelhead from the 1996 brood were ponded in one OR raceway on 10 August 1996 at about 500 fish/lb. On 31 October 1996, fish from one OR raceway was split into three MI raceways by small or large grade at 59, 31, and 31 fish/lb. To observe if the removal of baffles improved fish health, baffles were removed from M8A and M8C on 23 October 1996 (see report B). Marking with CWTs and fin clips was completed in mid-November. Dry feed conversion ratios ranged from 0.86-1.02. Michigan raceways produced an average of 148 fish/gpm. Production cost was \$0.91 per fish and \$0.98 when marking costs were included.

Data on smolt condition at release is presented in Tables 39-41. The percentage of smolts ranged from 1.5-45.9% in 1996 and the remaining fish were classified as intermediate smolts (one fish was classified as a parr). Adipose fin clip quality was greater than 94% recognizably clipped.

Paint marked, coded-wire-tagged, and production release and recovery data is presented in Tables 42-43. Only three paint marked fish were recovered at John Day Dam and five fish at Bonneville Dam in 1997, therefore, survival indices were not calculated. All paint mark recoveries were from fish reared in the first pass raceway, because fish from the second and third passes were not marked.

Adult Survival Studies

Smolt-to-adult survival estimates are presented in Table 44.

Adult Returns to the Umatilla River

The number of steelhead that returned to TMFD in 1996-97 was 1,463 hatchery fish and 1,013 wild fish for a total of 2,477 (Appendix Table 8). Vital statistics on adults and run timing are presented in Tables 45-46 and Figure 4. First and last trapping dates were 6 September 1996 and 30 June 1997. On 11 January 1997 counts peaked at 133 wild and 131 hatchery steelhead. Of 94 CWT fish collected, 14 were identified as strays released from Lyons Ferry Hatchery (tag code and (N) were 635717(4), 635718(6), 635748(1)). Other hatchery fish and CWT's represented were: Big Canyon acclimation facility, Wallowa River 070327 (1), Spring Creek acclimation facility, Wallowa River 075822 (1) and Little Sheep Creek, Imnaha River 075820 (1).

Table 36. Egg-take and survival of summer steelhead reared at Umatilla Hatchery, brood years 1991-96.

Egg source	Brood year	Number of eggs taken or received	Egg-to-fry survival (%)	Egg-to-smolt ^a survival (%)
Umatilla River	1991	340,674	78.4	66.6 ^b
Umatilla River	1992	423,810	47.2	43.3 ^c
Umatilla River	1993	255,000	73.7	60.0
Umatilla River	1994	234,000	84.6	63.1
Umatilla River	1995	223,525	86.1	65.6
Umatilla River	1996	224,000	85.7	61.3

^a Survival estimate is based on green egg-to-smolt stage.

^b Survival estimate does not include 5,443 smolts removed for passage evaluation nor 27,860 that were graded and removed.

^c Survival estimate does not include 25,090 sac fry that were destroyed because of a reduction in program goals.

Table 37. Rearing conditions immediately before transfer for summer steelhead in Michigan raceways at Umatilla Hatchery and in Oregon raceways at Irrigon Hatchery.

Brood year	System	Maximum density (lb/ft ³)	Maximum loading (lb/gal/min)
1991	Michigan	5.4-6.7	11.8-14.6
1991	Oregon	1.3	6.6
1992	Michigan	4.0-4.5	8.9-9.9
1992	Oregon	1.3	6.6
1993	Michigan	3.8-4.6	8.4-10.1
1993	Oregon	1.4-1.5	6.7-7.4
1994	Michigan	4.0-4.2	9.7-10.2
1994	Oregon	1.3-1.4	7.3-10.4
1995	Michigan	4.1-4.3	9.8-10.4
1995	Oregon	1.2-1.4	5.9-6.9
1996	Michigan	3.4-3.9	8.1-9.3
1996	Oregon	1.3-1.5	7.1-8.0

Table 38. Water quality comparisons in first, second, and third pass Michigan raceways used to rear summer steelhead in 1996-97.

Parameter measured	Mean parameter value					
	A pass	N	B pass	N	C pass	N
Sampling period	Nov 1-Apr 11		Nov 1-Mar 6		Nov 1-Mar 6	
Temperature head (°C)	12.3	23	12.3	19	12.3	19
Temperature tail (°C)	12.2	23	12.2	19	12.3	19
pH head	7.7	20	7.7	16	7.7	16
pH tail	10.2	20	7.7	16	7.6	16
Oxygen head (ppm)	12.0	22	12.5	18	12.7	18
Oxygen tail (ppm)	9.2	22	9.6	18	9.3	18
Nitrogen head (mmHg)	598	22	583	18	575	18
Nitrogen tail (mmHg)	616	22	604	18	596	18
Total pressure-head (mmHg)	772	22	767	18	759	18
Total pressure-tail (mmHg)	751	22	774	18	731	18
Unionized ammonia (µg/l)	1.01	9	1.42	7	1.96	7
Alkalinity (mg/l CaCO ₃)	137	11	133	9	133	9

Table 39. Mean length, weight, and condition factor for summer steelhead reared in Michigan and Oregon raceways at Umatilla Hatchery in 1996-97, 1996 brood.

Sample	Pass	Length(mm)		Weight(g)		Condition Factor	
		N	Mean(SE)	N	Mean(SE)	N	Mean(SE)
Oregon							
August:	A	66	61.8(0.7)	50	2.8(0.1)	50	1.14(0.01)
September:	A	106	77.4(0.9)	89	5.7(0.3)	89	1.16(0.01)
Michigan							
October:	A	98	91.3(0.7)	58	7.9(0.2)	58	1.02(0.01)
	B	109	110.4(1.1)	57	14.6(0.6)	57	1.04(0.01)
	C	129	106.4(0.9)	56	13.0(0.5)	56	1.06(0.01)
November:	A	162	101.5(0.8)	74	13.6(0.5)	74	1.18(0.01)
	B	155	123.6(1.1)	50	26.1(1.3)	50	1.17(0.01)
	C	152	121.9(1.2)	61	23.8(1.0)	61	1.18(0.01)
December:	A	108	128.3(1.4)	64	26.2(1.4)	64	1.19(0.01)
	B	103	153.0(1.5)	51	45.0(2.1)	51	1.13(0.02)
	C	101	154.8(1.5)	49	44.0(1.9)	49	1.17(0.01)
January:	A	102	145.5(1.6)	77	36.3(1.3)	77	1.09(0.01)
	B	106	171.1(1.9)	51	61.2(3.0)	51	1.15(0.01)
	C	99	181.0(2.1)	49	69.8(3.1)	49	1.11(0.01)
February:	A	112	166.7(1.9)	56	53.3(2.7)	56	1.13(0.02)
	B	109	196.0(1.7)	59	81.7(2.8)	59	1.07(0.01)
	C	104	192.7(1.8)	52	80.5(3.2)	52	1.071(0.01)
March:	A	100	183.3(2.4)	57	73.4(2.8)	57	1.08(0.01)
Release:	A	301	208.3(1.0)	99	93.3(2.3)	99	0.99(0.01)
	B	502	208.1(0.9)	381	99.5(1.5)	380	1.08(0.01)
	C	304	203.5(1.1)	202	84.8(1.7)	202	0.95(0.01)

Table 40. Mean length, weight, and condition factor at release for summer steelhead reared in first, second, and third pass Michigan raceways at Umatilla Hatchery, 1991-96 broods (standard error in parentheses).

Brood year	Pass	Length (mm)	Weight (g)	Condition factor
1991	A	194.3(1.4)	91.0(3.2)	1.13(0.01)
	B	200.0(1.1)	90.2(2.4)	1.09(0.01)
	C	186.9(1.0)	76.7(2.1)	1.12(0.01)
1992	A	199.6(1.1)	74.8(2.1)	0.93(0.01)
	B	198.2(1.2)	80.9(2.7)	1.01(0.01)
	C	220.1(1.0)	102.4(2.5)	0.93(0.01)
1993	A	205.9(1.2)	86.7(2.5)	0.97(0.01)
	B	198.3(1.2)	88.7(2.4)	1.05(0.01)
	C	214.2(1.1)	93.3(2.3)	0.94(0.01)
1994	A	206.3(1.1)	82.6(2.2)	0.90(0.01)
	B	209.7(1.0)	96.2(2.7)	1.00(0.01)
	C	205.9(0.8)	81.4(1.8)	0.90(0.01)
1995	A	207.9(1.1)	87.3(2.4)	0.99(0.01)
	B	206.8(1.3)	89.9(2.9)	0.98(0.01)
	C ^a			
1996	A	208.3(1.0)	93.3(2.3)	1.00(0.01)
	B	208.1(0.9)	99.5(1.5)	1.08(0.00)
	C	203.5(1.1)	84.8(1.7)	0.95(0.00)

^a The 1995 brood steelhead from pond M8C escaped from the acclimation pond prior to sampling.

Table 41. Mean proportion of descaled, partially descaled, and undamaged summer steelhead reared in Michigan passes at Umatilla Hatchery, brood years 1991-96.

Brood year	Pass	Descaled ^a	Partially Descaled ^b	Undamaged ^c
1991	A	0.01	0.43	0.56
1991	B	0.05	0.39	0.61
1991 ^d	C			
1992	A	0.08	0.30	0.62
1992	B	0.03	0.56	0.41
1992	C	0.02	0.58	0.40
1993	A	0.05	0.13	0.82
1993	B	0.01	0.50	0.49
1993	C	0.11	0.33	0.56
1994	A	0.13	0.39	0.48
1994	B	0.00	0.21	0.79
1994	C	0.09	0.42	0.50
1995	A	0.03	0.70	0.28
1995	B	0.01	0.31	0.69
1995 ^e	C			
1996	A	0.12	0.48	0.41
1996	B	0.02	0.35	0.63
1996	C	0.32	0.57	0.11

^a More than 0.20 descaling on either side of the fish.

^b Descaling = 0.03 to 0.20 on either side of the fish.

^c Less than 0.03 descaling on either side of the fish.

^d Data not available.

^e The 1995 brood steelhead from pond M8C escaped from the acclimation pond prior to sampling.

Table 42. Coded-wire tag and paint mark information for steelhead reared at Umatilla Hatchery and released in 1997, 1996 brood (CWT = coded-wire-tag, AD = adipose fin, LV = left ventral fin).

Raceway	CWT code	Number CWT ^a	Paint mark		Fin location	Fin clip	Number released
			Number	Color			
M8A	091837	20,065	8,655	Mixed ^b	Anal	ADLV	49,944
M8B	091836	19,103				ADLV	46,788
M8C	091835	19,531				ADLV	41,555

^a Number recognizably coded-wire-tagged and released. All CWT fish are also adipose fin clipped and all fish received a left ventral fin clip.

^b Fish were paint marked with orange (1,511), mustard yellow (5,003), and red (2,141).

Table 43. Recovery data for branded or paint marked steelhead reared in A, B, and C pass Michigan raceways at Umatilla Hatchery, released in the Umatilla River, and recaptured at John Day Dam, 1992-96 (number of observed recoveries in parentheses).

Brood year	Replicate groups per pass	Mean percent of number released		
		Pass		
		A	B	C
1992	1		28.7 (67)	19.5 (59)
1993	1	2.0 (53)	8.4 (51)	3.7 (22)
1994	1	2.0 (6)	3.0 (4)	2.0 (3)
1995	1	0.0 (0)	0.0 (0)	0.8 (1)
1996	1	(3)	*	*
Mean		3.6 (59)	10.0 (122)	5.1 (85)

*No fish marked in these passes.

Table 44. Total catch, escapement and survival of steelhead that were coded-wire-tagged (CWT) and released in the Umatilla River, 1991-93 brood years. Recoveries are incomplete for all brood years. Estimates of number of adults recovered are based on total production in each raceway.

Brood year, CWT code	Raceway	N ^a	Total exploit- ation rate (%)	Umatilla return rate (% of release)	Total survival rate (% of release)	Number of adults recovered
1991						
075838	M5A	1	0.0	0.01	0.00	2
075839	M5A	1	0.0	0.01	0.00	2
075840	M5A	1	0.0	0.01	0.00	2
075841	M5B	2	100.0	0.00	0.02	4
075842	M5B	0	0.0	0.00	0.00	0
075843	M5B	4	100.0	0.00	0.04	9
074127	M5C	27	0.0	0.26	0.26	58
073862	M5C	14	42.9	0.08	0.13	30
073759	M5C	23	57.0	0.13	0.22	50
Total		73	34.0	0.06	0.07	141
1992						
076052	M5A	8	0.0	0.06	0.06	13
076053	M5A	11	0.0	0.10	0.10	21
076054	M5A	8	0.0	0.08	0.08	18
076055	M5B	58	6.9	0.54	0.58	92
076056	M5B	56	3.6	0.40	0.59	95
076057	M5B	59	13.6	0.53	0.61	98
076058	M5C	70	21.4	0.54	0.69	103
076059	M5C	42	11.9	0.38	0.43	64
076060	M5C	74	21.6	0.61	0.78	117
Total		386	13.0	0.34	0.42	621
1993						
070139	M5A	4	0.0	0.05	0.05	12
070140	M5A	0	0.0	0.00	0.00	0
070141	M5B	31	12.9	0.27	0.31	77
070142	M5B	59	18.6	0.32	0.59	147
070143	M5C	32	12.5	0.27	0.31	81
070144	M5C	60	11.7	0.55	0.62	155
Total		186	14.0	0.25	0.33	473

^a Expanded CWT recoveries

Table 44. (continued)

Brood year, CWT code	Raceway	N ^a	Total exploit- ation rate (%)	Umatilla return rate (% of release)	Total survival rate (% of release)	Number adults recovered
1994						
070655	M5A	33	0.0	0.17	0.17	80
070656	M5B	135	0.0	0.72	0.72	359
070657	M5C	159	0.0	0.82	0.82	408
Total		327	0.0	0.56	0.56	847

Table 45. Vital statistics for steelhead that returned to the eastbank fish ladder, Three-Mile Falls Dam, Umatilla River, 1995-96.

Origin ^a	Number		Number		Number		Total	%
	male	%	female	%	unknown	%		
Hatchery	743	50.8	720	49.2	0	0.0	1,463	59.1
Wild	272	26.8	742	73.2	0	0.0	1,014	40.9
Total	1,015	41.0	1,462	59.0	0	0.0	2,477	100.0

^a Origin determined by presence or absence of adipose fish. Thirteen hatchery fish were strays based on coded-wire tags.

Table 46. Vital statistics of wild (unmarked) and hatchery steelhead that returned to the Umatilla River, run year 1996-97. Data for hatchery fish was determined from coded-wire tag recovery of Umatilla origin fish. Age of wild fish was determined from scale analysis (P. Kissner, CTUIR, personal communication). Sex was determined visually.

Brood year	Age	Number	Sex	Fork length (mm)		
				mean	min	max
Wild						
1991	3.2	5	male	725	585	820
		5	female	741	681	885
1992	3.1	5	male	562	540	576
		1	female	601		
	2.2	4	male	737	719	775
		11	female	737	690	791
1993	2.1	10	male	625	574	680
		9	female	602	540	650
Hatchery						
1993	1.2	3	male	775	745	800
1993	1.2	7	female	746	655	785
1994	1.1	39	male	621	539	700
1994	1.1	31	female	617	551	573

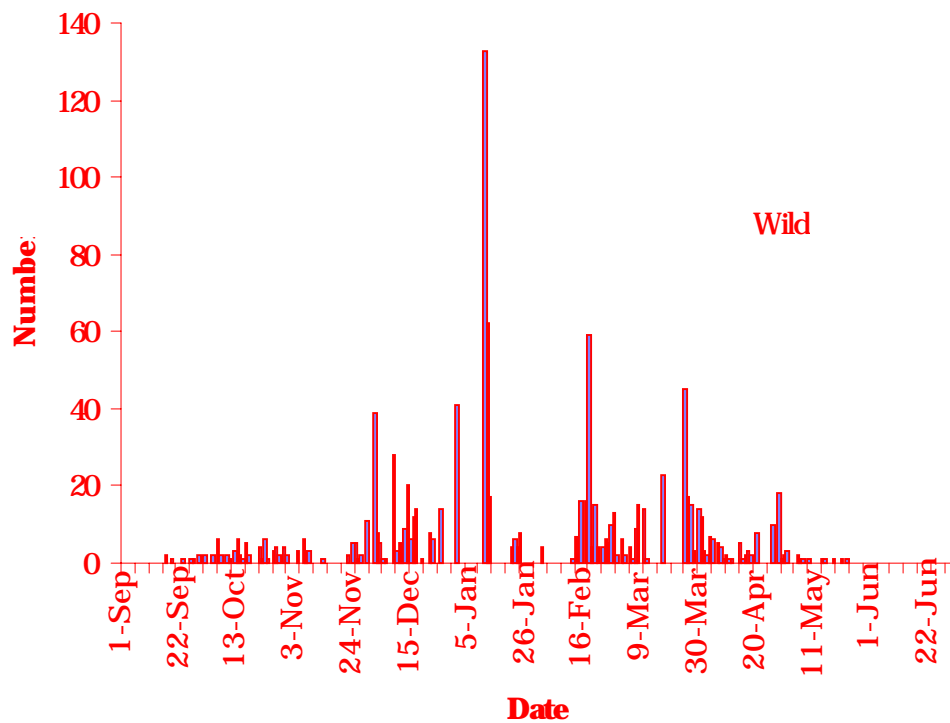
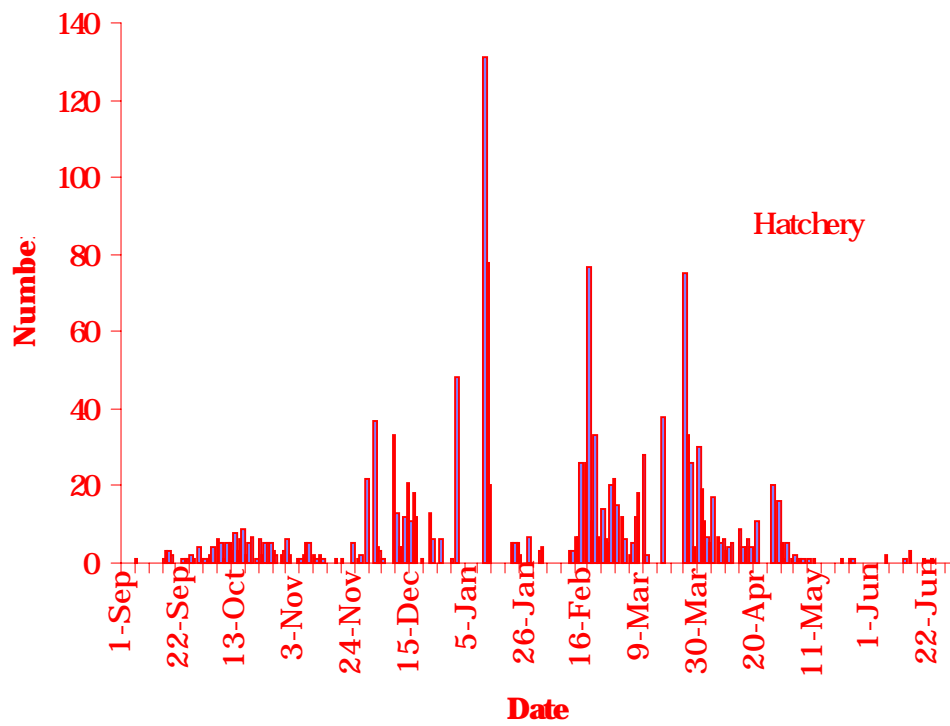


Figure 4. Numbers of wild and hatchery steelhead counted at the east-bank fish ladder, Three Mile Falls Dam, Umatilla River, 1996-97.

Fishery

Catch and harvest data for the steelhead sport fishery is presented in Tables 47-48. Angler residency in 1996-97 (N=1,305) was 95.7% Umatilla and Morrow counties, 3.2% other Oregon counties, and 1.1% out of state. The observed catch of 57 steelhead below TMFD consisted of 56% hatchery and 44% wild (all wild fish were released). Twelve CWT steelhead were recovered in the fishery. Expanded CWT recoveries in section one by code were: 3 (070140), 2 (070141), 4 (070655), 3 (070656), 4 (070657), 4 (635717), 2 (636748).

Discussion

Juvenile Rearing and Survival Studies

Juvenile rearing and smolt condition for steelhead were similar to previous years with few differences among passes. Smolt assessment showed that a greater percentage of fish reared in the first pass raceway were identified as smolts (45.9%) than fish reared in second and third pass raceways (4.4% and 1.5%). Removal of baffles did not appear to reduce descaling. Fish from first and third pass raceways (baffles removed) had greater scale loss compared to fish in the second pass raceway (baffles installed). Fin erosion was similar to previous years with most fish suffering moderate to severe erosion of the dorsal fin (Keefe et al. 1993, 1994, Hayes et al. 1996a, 1996b, and Focher et al. 1998). Rearing density for steelhead at UFH was approximately two times greater than Imnaha or Wallowa stock reared at IFH. However, loading rates were similar for both groups. Conversion of dry feed was more efficient for Umatilla steelhead (0.96 lb feed/lb fish) than for Imnaha (1.12) or Wallowa (1.09) steelhead. Only three paint marked fish were recovered at John Day Dam in 1997; therefore no analysis of relative survival and migration rate was possible.

Adult Survival Studies

Smolt-to-adult survivals of graded medium and large fish released in April have ranged from 0.31-0.82% since rearing densities were lowered for the 1992 brood. In comparison, survival of graded small fish released in May has ranged from 0.00-0.17%. Although graded for a small size, fish released in May have similar length frequency distributions to groups released in April. This indicates that poor survival may be a function of release date. Managers should consider a shorter period of acclimation for the graded small fish and release them at an earlier date.

Current survival rates are below the master plan goal of 2.7% (ODFW and CTUIR 1990) and the goal may need to be reevaluated. However, recent ocean conditions have been poor for adult survival and historical data from the Umatilla River (Rowan 1996) and Snake River basin (Fletcher, ODFW personal communication, Schuck et al. 1997) suggests that greater survival is possible. In-basin survival studies (S. Knapp, ODFW personal communication) are currently being analyzed to identify if hatchery fish suffer significant mortality within the Umatilla River before the smolts migrate to the ocean.

Table 47. Estimated catch statistics for steelhead in the Umatilla River in 1996-97. Lower river = Mouth of the Umatilla River to Three Mile Falls Dam. Upper River = Stanfield Dam to the lower boundary of the Confederated Tribes of the Umatilla Indian Reservation boundary. Number caught and number harvested includes \pm 95% confidence interval.

Month	Number sampled		Hours	Number	Number	Catch
Day type	days	anglers	fished	caught	harvested	rate (fish/h)
Lower River						
September						
Weekday	8	24	170	0± 0	0± 0	0.00
Weekend	9	22	418	3± 3	3+ 4	0.01
Total	17	110	588	3± 3	3± 4	0.00
October						
Weekday	12	150	518	17+ 18	4± 6	0.01
Weekend	9	216	736	13± 1	7± 4	0.02
Total	21	366	1254	30± 9	11± 7	0.01
November						
Weekday	10	75	258	39± 9	29±20	0.08
Weekend	11	197	703	33± 27	17±10	0.05
Total	21	272	961	72± 26	45±22	0.06
December						
Weekday	12	37	120	65± 11	7±14	0.40
Weekend	8	24	120	4± 3	0± 0	0.03
Total	20	51	240	68± 63	7±14	0.25
January						
Weekday	3	12	37	40± 75	0± 0	0.20
Weekend	3	15	42	0± 0	0± 0	0.00
Total	6	27	79	40± 75	0± 0	0.09
February						
Weekday	6	153	153	0± 0	0± 0	0.00
Weekend	3	35	35	0± 0	0±0	0.00
Total	9	188	188	0± 0	0±0	0.00
Lower river						
Total	94	878	3331	203±102	66±27	0.04

Table 47 (continued).

Month	Number sampled		Hours	Number	Number	Catch
Day type	days	anglers	fished	caught	harvested	rate (fish/h)
Upper River						
January						
Weekday	16	30	222	0± 0	0± 0	0.00
Weekend	7	47	302	8± 10	0± 0	0.02
Total	23	77	524	8± 10	0± 0	0.02
February						
Weekday	14	33	348	13± 26	0± 0	0.04
Weekend	6	44	281	4± 6	0± 0	0.01
Total	20	77	629	17± 27	0± 0	0.02
March						
Weekday	12	35	222	10± 16	4± 7	0.04
Weekend	8	132	420	16± 12	8± 8	0.04
Total	20	167	642	26± 20	12±10	0.04
April						
Weekday	11	39	373	10± 17	5± 9	0.03
Weekend	4	118	452	21± 6	8± 6	0.05
Total	15	157	825	31± 18	13±11	0.04
Upper river						
Total	78	478	2620	81± 39	24±15	0.03
Grand						
Total	172	1356	5931	284±109	90±31	0.04

Table 48. Summary of steelhead catch statistics, 1992-96. Data is combined from lower river (Umatilla mouth to Three Mile Falls Dam) and upper river (Barnhart Bluffs to lower boundary of the Confederated Tribes of the Umatilla Indian reservation).

Year ^a	Number anglers	Hours fished	Number caught	Number harvested	Catch rate (fish/h)
1992-93	543	5,293	177	37	0.03
1993-94	577	4,504	63	19	0.02
1994-95	1,070	6,172	257	61	0.05
1995-96	880	4,560	232	60	0.06
1996-97	1,356	5,931	294	90	0.04

^a Angling season in 1992-93 and 1993-94 was from 1 December to 15 March. Beginning in 1994-95 the angling season was from 1 September to 15 April.

Adult Returns to the Umatilla River

The return of 2,477 adults in 1996-97 was similar to the 16 year average (2,101) and the hatchery return (1,463) was the greatest on record. The pre-season prediction for the total run was $1,890 \pm 1,009$ (95% CI) and the wild prediction was $1,033 \pm 1,031$ (95% CI). Estimates were based on 16 years (total run, $r^2=0.67$) and 7 years (wild run, $r^2=0.48$) of regression data comparing Umatilla returns to the "A" steelhead run at Bonneville Dam (ODFW unpublished data). The poor accuracy of the prediction of the total run may have been caused by recent changes in the hatchery program which were not reflected in the regression analysis.

There may be cause for concern if hatchery fish continue to make up a high percent of the total run. The percentage of hatchery fish in the 1996-97 run was 59% compared to a mean of 30% since 1989. However, run timing, length of ocean rearing, and average size for one- and two-ocean hatchery fish continued to emulate wild fish. This data provides circumstantial evidence that the life history characteristics of the wild population are not being altered. The distribution and reproductive success of naturally spawning fish of hatchery-origin still needs to be determined to evaluate the success of supplementation.

Hatchery fish that stray into the Umatilla River are a concern because they may be used for broodstock or breed with natural spawners causing outbreeding depression. From tag recovery data we determined that 2 of 59 (3.4%) males used for broodstock were strays. This percentage approaches the maximum straying rates recommended by the stray workshop symposium (Grant 1997). We suggest reading tags during spawning to eliminate the use of stray broodstock. More importantly, we estimated that 252 of 2,477 (10.1%) fish passing TMFD were strays. It is unclear whether these fish temporarily entered the basin or remained to spawn with naturally produced steelhead. Studies may be needed to determine whether strays are breeding with natural spawners.

Fishery

Total fishing effort (791 h/month) and catch rates (0.04 fish/h) in 1996-97 were typical compared to previous years (608-1323 h/month and 0.02-0.06 fish/h). Harvest estimates below TMFD represented 2.6% of the 1996-97 corrected steelhead count at TMFD. Estimated harvest for combined lower and upper river sections was 3.5% of the run. Harvest estimates from punch cards in fall 1996 were 76 fish compared to an estimate of 66 ± 27 fish for creel data (J. Leppink, ODFW personal communication). This is similar to previous data when punch cards estimates were greater than creel survey estimates. Underestimation of harvest from creel survey data may indicate significant fishing activity in areas of the river that are not surveyed.

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APPENDIX TABLES

Appendix Table 1. Release data for salmon and steelhead reared at Umatilla and Little White Salmon hatcheries and released in the Umatilla River in 1997 (Acclimation facilities: BS=Bonifer Springs; IC = Imeques-c-mem-ini-kem; MI=Minthorn; TH = Thornhollow).

Race-species, release strategy, system	Brood year	Date released	Number released	Mean fork length (mm)	Mean weight (g)	Accli- mation (days)	Release location
Umatilla Hatchery							
Fall chinook salmon							
Subyearlings							
Michigan	1996	29-30 May 1997	2,580,833	85.1	6.8	17	IC/TH
Yearlings							
Michigan	1995	25 Mar 1997	153,043	172.4	58.5	35-37	IC/TH
Oregon		25 Mar 1997	105,910	168.5	56.1	35-37	TH
Total			258,953				
Spring chinook salmon							
Yearlings							
Oregon	1995	26 Mar 1997	225,883	160.7	49.9	64	IC
Summer steelhead							
Michigan	1996	3-10 Apr & 15 May 1997	41,555	203.5	84.8	22-64	BS ^a
Michigan		3-11 Apr 1997	46,788	209.0	99.7	21-29	MI
Michigan		6-15 May 1997	48,944	208.3	93.3	22-31	BS
Total			137,287				
Little White Salmon Hatchery							
Fall chinook salmon							
Yearlings							
Oregon	1995	30 Mar 1997	260,968	142.8	33.5	1-2	TH

^a Approximately 5,000 fish were released on 15 May 1997

Appendix Table 2. Release data for subyearling fall chinook salmon reared at Umatilla Hatchery and released in the Umatilla River (RM= river mile, TH=Thornhollow acclimation facility, RM 73.5; IC=Imeqes-C-mem-ini-kem acclimation facility, RM 80).

Brood year, CWT code	Release date	Race- way	Number released ^a	Number CWT	Number with brand paint mark	Fish per pound	Release location
1991							
071433	051892	M2A	305,878	29,066	7,445	61.0	42.5
071434	051892	M3A	306,802	31,224	6,917	65.7	42.5
071435	051892	M2B	297,331	30,326	9,643	60.9	42.5
071436	051892	M3B	302,555	30,365	7,049	61.9	42.5
071437	051892	M2C	223,830	30,508	7,526	55.2	42.5
071438	051892	M3C	301,831	30,924	7,656	64.5	42.5
subtotal			1,738,227	182,413	46,236	61.8	
071430	051992	O2A	281,350	32,287	9,174	65.1	42.5
071429	052092	O3A	286,578	31,892	6,272	70.6	42.5
071432	051992	O2B	191,257	29,425	8,558	58.3	42.5
071431	051992	O3B	182,931	28,951	8,863	56.2	42.5
subtotal			942,116	122,555	32,867	63.7	
Total			2,680,343	304,968	79,103	62.5	
1992							
076330	052493	M2A	292,895	28,964	10,027	63.0	73.5
076331	052493	M3A	282,125	29,537	10,053	67.0	73.5
070127	052493	M2B	269,336	27,063	10,150	63.4	73.5
076333	052493	M3B	273,662	29,718	10,020	60.3	73.5
076334	052493	M2C	282,175	29,958	9,434	68.0	73.5
076332	052493	M3C	277,931	29,451	9,894	61.5	73.5
subtotal			1,678,124	174,691	59,578	63.9	
070126	052593	O2A	268,001	29,594	10,458	59.3	73.5
070125	052593	O3A	272,496	29,360	9,828	59.4	73.5
076329	052593	O2B	203,731	30,706	10,278	59.4	73.5
076335	052593	O3B	207,565	30,462	10,547	59.4	73.5
subtotal			951,793	120,820	41,173	59.4	
Total			2,629,917	295,511	101,361	62.3	
1993							
070663	52394	M2A	322,867	31,162	10,171	63.0	73.5
070719	52394	M3A	327,700	31,658	9,725	72.4	73.5
070720	52394	M2B	314,518	30,528	10,008	65.4	73.5
070723	52394	M3B	326,408	30,447	10,217	68.2	73.5
070722	52394	M2C	303,843	30,950	9,769	68.0	73.5
070721	52394	M3C	306,105	28,474	9,373	68.7	73.5
subtotal			1,901,441	183,219	59,263	65.5	

^a All fish were RV fin clipped and all CWT fish were adipose fin clipped. Beginning with the 1993 brood, all non CWT fish were tagged with blank-wire.

Appendix Table 2 (continued)

Brood year, CWT code	Release date	Race- way	Number released ^a	Number CWT	Number with brand/ paint mark	Fish per pound	Release location
1993							
070662	52494	O2A	280,046	31,239	10,158	60.1	73.5
070718	52494	O3A	279,965	31,040	10,220	64.2	73.5
070716	52494	O2B	191,321	30,502	10,906	59.1	73.5
070717	52494	O3B	190,439	32,481	10,260	60.0	73.5
subtotal			941,771	125,262	41,544	61.1	
Total			2,843,212	308,481	103,331	65.4	
1994							
071019	53195	M2A	286,459	29,353	10,665	63.5	IC
071017	53195	M3A	271,129	29,736	10,172	68.0	IC
071022	53195	M2B	280,406	28,472	10,323	64.4	IC
071020	53195	M3B	275,613	29,460	10,183	67.8	IC
071025	53195	M2C	274,110	29,784	10,176	66.5	TH
071023	53195	M3C	287,313	28,623	10,249	59.8	TH
subtotal			1,675,030	175,428	61,768	64.9	
071026	53195	O1A	245,885	30,106	10,374	57.2	IC
071018	53195	O3A	241,342	29,132	10,438	65.0	IC
071024	53195	O1B	151,943	30,204	10,248	63.6	IC
071021	53195	O3B	152,098	29,327	11,104	57.5	IC
subtotal			791,268	118,769	42,167	60.9	
Total			2,466,298	294,197	103,946	63.6	
1995							
071320	053096	M2A	303,803	30,015	10,557	69.5	IC
071321	053096	M3A	299,233	28,997	9,407	68.4	IC
071323	053096	M2B	300,377	29,914	9,965	62.8	IC
071325	053096	M3B	300,895	30,220	10,389	67.4	IC
071157	053196	M2C	393,339	29,852	10,316	72.8	TH
071327	053196	M3C	460,259	28,476	10,378	69.5	TH
	053196	M4C	251,582			66.3	TH
subtotal			2,309,488	177,474	61,012	68.3	
071322	053096	O2A	266,913	29,646	10,252	57.2	IC
071324	053096	O3A	272,594	30,243	10,420	66.4	IC
071326	053096	O2B	181,291	30,238	10,237	56.5	IC
071328	053096	O3B	181,709	30,455	9,980	60.3	IC
subtotal			902,507	120,582	40,889	60.5	
Total			2,960,413	298,056	101,901	66.1	

Appendix Table 2 (continued)

Brood year, CWT code	Release date	Race- way	Number released ^a	Number CWT	Number with brand/ paint mark	Fish per pound	Release location
1996							
092129	053097	M1A	294,417	33,161	8,469	63.6	IC/TH
092130	053097	M1B	294,043	32,464		62.4	IC/TH
092132	052997	M1C	304,993	31,382		66.8	IC
092131	053097	M2A	395,493	31,844	8,094	67.9	IC/TH
092133	052997	M2B	394,250	33,273		70.7	IC
092134	052997	M2C	311,016	33,460		67.6	IC
092126	053097	M4A	197,028	33,555	9,000	67.2	TH
092127	052997	M4B	195,031	32,764		70.2	IC
092128	052997	M4C	194,562	29,732		65.6	IC
Total			2,580,833	291,635	27,238	67.0	

Appendix Table 3. Release data for yearling fall chinook salmon reared at Bonneville and Umatilla Hatcheries and released in the Umatilla River (RM= river mile, TH=Thornhollow acclimation facility, RM 73.5).

Brood year, CWT code	Release date	Race- way	Number released ^a	Number CWT	Number with brand/ paint mark	Fish per pound	Release location (RM)
Bonneville Hatchery							
1990							
075619	031992	A8	122,639	26,160		7.5	56.0
075618	031792	A9	97,801	26,178		7.5	70.0
Total			220,440	52,338		7.7	
1991							
071461	031893	A5	66,345	23,239		8.7	73.5
071460	031893	A6	68,492	23,863		9.1	73.5
Total			134,837	47,102		8.9	
1992							
070252	041994	A5	49,824	23,470		8.5	73.5
070255	032394	A6	233,629	23,699		10.4	73.5
Total			283,453	47,169		9.5	
1993							
070658	040795	A2	111,817	24,865		7.8	TH
070659	040795	A5	115,271	24,374		8.2	TH
Total			227,088	49,239		8.0	
1994							
071037	040596	A4	204,022	27,397	5,218	7.0	TH
071038	041896	A3	217,294	28,521	5,111	7.0	IM
Total			421,316	55,918	10,329	7.0	

^a All fish were RV fin clipped and all CWT fish were adipose fin clipped. Beginning with the 1992 brood, all non CWT fish were tagged with blank-wire.

(Appendix Table 3, continued)

Brood year, CWT code	Release date	Race- way	Number released ^a	Number CWT	Number with brand/ paint mark	Fish per pound	Release location (RM)
Umatilla Hatchery							
1994							
071039	041896	M3A	48,499	23,238	5,197	5.3	IM
071040	041896	M3B	47,463	23,442	5,449	4.7	IM
071041	041896	M3C	47,125	23,343	5,313	5.3	IM
Total			143,087	70,023	15,959	5.1	
1995 ^b							
091729	032597	O3A	53,993	25,250	4,180	7.6	IM/TH
091748	032597	O3B	51,917	25,260		7.6	IM
subtotal			105,910	50,510	4,180	7.6	
091358	032597	M1A	51,112	25,983	4,798	8.2	TH
091807	032597	M1B	51,066	25,258		8.2	TH
091359	032597	M1C	50,865	25,232		8.1	TH
subtotal			153,043	76,473	4,798	8.2	
Total			258,953	126,983	8,978	7.9	
Little White Salmon							
1995							
070953	033097	45	169,478	29,983		13.7	TH
070954	033097	46	91,490	30,344		13.4	TH
Total			260,968	60,327		13.6	

Appendix Table 4. Release data for subyearling spring chinook salmon reared at Umatilla Hatchery and released in the Umatilla River (RM= river mile)

Brood year, CWT code	Release date	Race- way	Number released ^a	Number CWT	Number with brand/ paint mark	Fish per pound	Release location (RM)
1991							
071443	051392	O4A	97,013	50,611	8,392	32.1	80
071444	051292	O4B	63,585	48,051	8,384	31.2	80
071445	051292	O5B	63,305	49,498	6,572	32.2	80
071446	051392	O5A	95,456	50,045	8,195	32.1	80
Total			319,359	198,205	31,544	31.9	
071447	051292	M6A	104,670	50,047	9,877	36.4	80
071448	051292	M7A	104,929	51,707	9,903	36.3	80
071449	051192	M6B	109,528	51,518	10,442	38.3	80
071450	051292	M7B	109,997	51,271	9,816	37.8	80
071451	051192	M6C	98,617	52,128	10,148	39.2	80
071452	051192	M7C	108,652	51,659	9,609	36.8	80
Subtotal			636,393	308,330	59,256	37.5	
Total			955,752	506,535	90,800	35.6	
1992							
076132	060193	M6C	113,852	52,893	10,033	28.4	80
076133	060193	M7C	116,316	52,335	10,372	27.7	80
076134	060193	M7B	111,333	51,963	10,139	27.9	80
076135	060193	M6B	109,473	51,680	9,961	28.2	80
076136	060293	M6A	105,290	52,588	9,127	28.6	80
076137	060293	M7A	111,103	52,172	9,137	26.9	80
Total			667,367	318,706	58,929	27.6	
1993							
070734	052094	M6A	140,255	49,726	8,889	30.7	80
070735	052094	M7A	142,237	52,298	9,217	30.7	80
070736	052094	M6B	140,227	52,636	9,998	30.3	80
070737	052094	M7B	142,003	53,172	10,182	30.3	80
070738	052094	M6C	138,665	51,042	9,872	30.5	80
070739	052094	M7C	135,990	52,317	9,925	30.5	80
Total			839,377	311,191	58,083	30.4	

^a All fish from even numbered brood years were LV fin clipped and fish from odd numbered brood years were RV fin clipped. All CWT fish were adipose fin clipped.

Appendix Table 5. Release data for spring chinook salmon released in the fall. Fish were reared at Umatilla and Bonneville Hatcheries and released in the Umatilla River (IC - Imeqes-C-mem-ini-kem)

Bonneville Hatchery							
Brood year, CWT code	Release date	Race- way	Number released ^a	Number CWT	Number with brand/ paint mark	Fish per pound	Release location (RM)
1991							
076042	110592	A11	25,104	25,104		13.0	80
076043	110592	A10/11	25,075	24,992		13.0	80
076044	110492	A10	15,730	15,423		13.1	80
076045	110392	A9	24,638	24,638		9.9	80
076046	110392	A8/9	24,715	24,221		10.0	80
076047	110392	A8	17,667	17,269		10.1	80
Total			132,929	131,647		11.5	
Umatilla Hatchery							
1991							
071542	110592	O3B	50,736	26,135		19.3	80
071543	110592	O3A	50,680	25,633		19.5	80
Total			101,416	51,768		19.4	
1992							
070155	111793	O2A	40,661	35,710		18.5	80
070156	111793	O3A	42,734	33,999		18.8	80
070157	111793	O2B	39,656	34,857		18.0	80
070158	111793	O3B	41,244	34,130		19.2	80
Total			164,295	138,696		18.6	
070159	111693	M2A	49,694	34,541		20.3	80
070160	111793	M3A	49,081	35,408		20.9	80
070161	111793	M2B	52,211	35,657		21.5	80
070162	111693	M3B	48,343	35,467		20.2	80
070163	111793	M3C	49,318	36,157		20.8	80
070216	111693	M2C	47,867	36,102		20.8	80
Total			296,514	213,332		20.8	
			460,809	352,028		20.0	

^a All fish from even numbered brood years were LV fin clipped and fish from odd numbered brood years were RV fin clipped. All CWT fish were adipose fin clipped.

Appendix Table 5 (continued)

Brood year, CWT code	Release date	Race- way	Number released	Number CWT	Number with brand/ paint mark	Fish per pound	Release location (RM)
1993							
070724	111594	M2C	39,548	34,124		9.0	IC
070725	111594	M3C	39,517	34,827		9.3	IC
070726	111594	M2B	39,551	35,156		10.5	IC
070727	111594	M3B	39,487	34,819		9.2	IC
070728	111594	M2A	38,234	34,808		9.5	IC
070729	111594	M3A	40,383	35,160		9.4	IC
Total			236,720	208,894		9.6	
070730	111594	O2A	37,073	34,915		7.2	IC
070731	111594	O1A	37,096	35,750		7.8	IC
070732	111594	O2B	32,687	32,251		7.4	IC
070733	111594	O1B	34,649	34,220		9.6	IC
subtotal			141,505	137,136		8.0	
Total			378,225	345,030		9.0	

Appendix Table 6. Release data for yearling spring chinook salmon. Fish were reared at Umatilla and Bonneville Hatcheries and released in the Umatilla River (IC - Imeqes-C-mem-ini-kem)

Brood year, CWT code	Release date	Race- way	Number released ^a	Number CWT	Number with brand/ paint mark	Fish per pound	Release location (RM)
Bonneville Hatchery							
1991							
071455	032393	B1	45,430	19,951		14.8	80
071456	032293	B2	46,112	20,022		14.3	80
Total			91,542	39,973		14.5	
1992							
070250	032594	B6	99,616	26,716		11.7	80
070251	032594	B5	101,830	26,305		11.7	80
075944	032594	B8	103,980	20,109	4,818	12.5	80
075945	032594	B7	99,676	20,219	5,200	12.2	80
Total			405,102	93,349	10,018	12.0	
1993							
070649	042195	B7	123,257	22,189	5,137	10.5	80
070650	042195	B8	124,614	24,088	4,878	10.2	80
070660	031395	B5	74,735	23,607		13.9	80
070661	041495	B6	74,921	28,765		11.4	80
Total			397,527	98,649	10,015	11.2	
Umatilla Hatchery							
1991							
075739	032393	O5B	50,312	21,499	5,300	8.2	80
075740	032393	O4B	50,109	20,880	4,934	8.1	80
075741	032493	O4A	54,347	21,157	5,548	8.3	80
075742	032493	O5A	54,014	20,307	5,242	8.6	80
Total			208,782	83,843	21,085	8.3	
1992							
070217	032194	O5A	51,210	20,070	5,082	8.5	80
070218	032194	O5B	49,375	19,920	5,142	8.1	80
070219	032194	O4B	52,620	20,971	5,151	8.8	80
070220	032294	O4A	51,938	20,982	5,419	8.4	80
Total			205,143	81,053	20,797	8.5	

^a All fish from even numbered brood years were LV fin clipped and fish from odd numbered brood years were RV fin clipped. All CWT fish were adipose fin clipped.

Appendix Table 6 (continued)

Brood year, CWT code	Release date	Race- way	Number released ^a	Number CWT	Number with brand/ paint mark	Fish per pound	Release location (RM)
1993							
071453	031395	M5A	50,007	20,315	4,910	8.3	80
071454	031395	M5B	40,685	15,661	4,436	8.9	80
			90,692	35,876	10,015	7.8	
070651	031395	O4A	49,001	18,864	5,176	9.1	80
070652	031395	O4B	44,077	19,052	4,975	8.2	80
070653	031395	O5B	44,188	18,175	5,133	9.0	80
070654	031395	O5A	47,846	19,091	5,063	8.7	80
subtotal			185,112	75,182	20,347	8.0	
Total			275,804	111,058	29,673	7.9	
1994							
071027	031396	M6A	49,032	19,622	5,083	9.0	IC
071028	031396	M6B	45,887	18,844	4,682	10.8	IC
071029	031396	M6C	49,121	19,258	5,275	9.0	IC
Total			144,040	57,724	15,040	9.6	
071030	031396	O4A	60,599	19,961	4,531	7.5	IC
071031	031396	O5A	60,137	20,066	5,026	8.8	IC
071032	031396	O5B	57,076	19,874	5,092	8.7	IC
071033	031396	O4B	56,709	19,583	4,232	9.5	IC
subtotal			234,521	79,484	18,881	8.6	
Total			378,561	137,208	33,921	9.0	
1995							
091730	032697	O4A	57,668	19,842	3,724	9.3	IC
091750	032697	O4B	56,901	20,289		9.3	IC
091749	032697	O5A	56,764	19,818		8.9	IC
091751	032697	O5B	54,550	20,597		8.9	IC
Total			225,883	80,546		9.1	

Appendix Table 7. Release data for summer steelhead reared at Umatilla Hatchery and released in the Umatilla River (RM= river mile; acclimation facilities: BS - Bonifer Springs, RM=63.5; MC - Meacham Creek; MI - Minthorn, RM=68.5; TH - Thornhollow, RM=68.5)

Brood year, CWT code	Release date	Race- way	Number released ^a	Number CWT	Number with brand/ paint mark	Fish per pound	Release location (RM)
1991							
075840	050192	M5A	22,288	10,105		5.5	MC
075838	050192	M5A	22,469	10,562		5.5	MC
075839	050192	M5A	22,662	10,275		5.5	MC
075841	043092	M5B	22,262	10,108		5.0	MC
075842	043092	M5B	21,365	9,498		5.0	MC
075843	043092	M5B	20,923	9,747		5.0	MC
074127	032992	M5C	22,059	10,203		5.8	BS & MI
073862	032992	M5C	22,902	10,594		5.8	BS & MI
073759	032992	M5C	22,474	10,394		5.8	BS & MI
Total			199,404	91,486		5.4	
1992							
076052	051393	M5A	65,465	13,117	9,055	6.1	BS
076053	051393	M5A		11,410		6.1	BS
076054	051393	M5A		9,907		6.1	BS
076055	041693	M5B	47,979	10,031	9,641	5.6	MI
076056	041693	M5B		9,418		5.6	MI
076057	041693	M5B		9,643		5.6	MI
076058	041893	M5C	44,824	10,194	8,863	4.5	BS
076059	041893	M5C		9,792		4.5	BS
076060	041893	M5C		9,440		4.5	BS
Total			158,268	92,952	27,559	5.5	
1993							
070139	051294	M5A	26,411	8,595	7,700	5.2	BS
070140	051294	M5A	25,686	8,400		5.2	BS
070141	041494	M5B	24,692	9,952	7,827	5.1	MI
070142	041494	M5B	24,906	9,965		5.1	MI
070143	041194	M5C	26,481	10,470	7,718	4.9	BS
070144	041194	M5C	24,922	9,651		4.9	BS
Total			153,098	57,033	23,346	5.1	

^aAll fish were adipose clipped and all CWT fish were also left ventral fin clipped

Appendix Table 7 (continued)

Brood year, CWT code	Release date	Race- way	Number released ^a	Number CWT	Number with brand/ paint mark	Fish per pound	Release location (RM)
1994							
070655	051295	M8A	47,941	19,782	8,908	5.5	BS
070656	041395	M8B	49,983	18,812	8,134	4.7	MI
070657	041195	M8C	48,539	19,290	7,771	5.6	BS
Total			146,463	57,884	24,813	5.3	
1995							
071034	050996	M8A	49,783	20,633	8,896	5.1	TH
071035	041296	M8B	47,543	19,742	8,615	5.1	MI
071036	042496	M8C	49,377	21,205	8,827	5.3	BS
Total			146,703	61,580	26,338	5.2	
1996							
091837 ^b	051597	M8A	48,944	20,065	8,655	4.9	BS
091836	041197	M8B	46,788	19,103		4.6	MI
091835 ^c	041097	M8C	41,555	19,531		5.4	BS
Total			137,287	58,699	8,655	4.9	

^bFish were paint marked with orange (1,511), mustard yellow (5,003), and red (2,141) on the anal fin.

^cApproximately 5,000 fish were released on 051597.

Appendix Table 8. Numbers of spring and fall chinook salmon, coho salmon, and steelhead counted at Three Mile Falls Dam, 1981-97 (chinook subjacks were <381 mm FL; chinook jacks were 382-610 mm FL; coho jacks were 382-508 mm FL).

Spring chinook salmon				Fall chinook salmon			
Year	Jack	Adult	Total	Subjack	Jack	Adult	Total
1985					6	79	85
1986					407	28	435
1987					348	125	473
1988			13		1466	94	1,560
1989			164	76	247	279	602
1990	32	2,158	2,190	621	107	333	1,061
1991	39	1,291	1,330	274	468	522	1,264
1992	4	450	454	0	64	239	303
1993	16	1,205	1,221	15	27	370	412
1994	8	263	271	368	236	688	1,292
1995	108	388	496	338	288	603	1,229
1996	121	2,152	2,273	606	80	646	1,332
1997	4	2,194	2,198				
Average	41	1,262	1,060	276	304	335	830

Steelhead				Coho Salmon			
Run year	Hatchery	Wild	Total	Year	Jack	Adult	Total
1981-82			768	1982			
1982-83			1,264	1982			
1983-84			2,062	1983			
1984-85			3,346	1984			
1985-86			2,959	1985			
1986-87			3,124	1986			
1987-88			2,782	1987			29
1988-89			2,474	1988			1,683
1989-90	246	1,422	1,668	1989	521	4,102	4,623
1990-91	387	724	1,111	1990	174	410	922
1991-92	523	2,246	2,769	1991	187	1,733	1,920
1992-93	617	1,297	1,914	1992	184	355	529
1993-94	345	945	1,290	1993	18	1,531	1,549
1994-95	656	875	1,531	1994	62	984	1,046
1995-96	785	1,296	2,081	1995	53	946	999
1996-97	1,463	1,014	2,477	1996	24	618	642
				1997	137	666	803
Average	628	1,227	2,101		151	1,261	1,340

REPORT B

Fish Health Monitoring and Evaluation

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FISH HEALTH MONITORING AND EVALUATION

INTRODUCTION

Fish health investigations proceeded as outlined in the Annual Operations Plan (AOP) during the sixth year of monitoring and evaluation for Umatilla Hatchery. Continued cooperative efforts with the Confederated Tribes of the Umatilla Indian Reservation (CTUIR) allowed for the collection of samples for *Renibacterium salmoninarum* (Rs) from marked adult spring chinook salmon returning to the Umatilla River. These data are used to evaluate different rearing strategies versus Rs infection level in spring chinook salmon juveniles reared under the Umatilla Hatchery program. Broodstock fish health sampling was done at facilities where eggs were taken and fertilized for Umatilla Hatchery. The 96 brood year fall chinook salmon production at Umatilla Hatchery was from Umatilla River adults spawned at the new Three Mile Dam Adult Facility and from Priest Rapids adults spawned at Priest Rapids. The 96 brood year spring chinook salmon production was from Umatilla River adults spawned at the new South Fork Walla Walla Adult Facility, and the 96 brood year summer steelhead production was from Umatilla adults spawned at Minthorn Ponds.

Two prophylactic aquamycin treatments for bacterial kidney disease (BKD) in spring chinook salmon juveniles were conducted under the Investigational New Animal Drug (INAD) process. The INAD requirements produce not only considerable administrative responsibility, but also some specific animal husbandry practices and diagnostic procedures for fish culture and fish health personnel while the INAD is in effect. Formalin treatments on adult summer steelhead at Minthorn Ponds, adult fall chinook salmon at Three Mile Dam Adult Facility, and adult spring chinook salmon at South Fork Walla Walla Adult Facility were administered under prescriptions. Erythromycin injections were given to adult spring chinook salmon at Three Mile Dam and South Fork Walla Walla adult facilities under prescriptions.

Preliberation examinations were conducted on all stocks and species at Umatilla Hatchery and at the Thornhollow and Imeqes C-mem-ini-kem acclimation facilities on the Umatilla River. Unlike most previous years of these investigations, there were no juvenile disease outbreak or increased loss examinations required at the hatchery or at the acclimation sites.

METHODS

Methods described in previous annual reports were used for the Umatilla Hatchery Fish Health Monitoring and Evaluation project (Keefe et al. 1993, Keefe et al. 1994, and Groberg et al. 1996). Once again, fisheries personnel of the CTUIR collected kidney samples from marked adult spring chinook salmon carcasses in the Umatilla River following release for natural spawning. Collection of these samples made it possible to determine Rs antigen levels by the enzyme-linked immunosorbent assay (ELISA).

The genus and species of the cold water disease (CWD) bacterium has been proposed for change from *Flexibacter psychrophilus* to *Flavobacterium psychrophilum* (Bernardet et al. 1996), so the proposed nomenclature will be used in this and future reports. Use of specific antisera allowed for confirmatory diagnoses of *F. psychrophilum*.

Juvenile Monthly Monitoring

On November 1, 1996, the protocol for conducting parasite examinations on five grab-sampled fish per month per lower index raceway was changed to random sampling of moribund fish. If no moribund fish were available, random sampling of some grab-sampled fish was done.

Juvenile Preliberation Monitoring

A t-test (Triola 1992) was used to compare log-transformed ELISA optical density (OD) values of 95 brood year fall chinook salmon in Oregon and Michigan raceways. Analysis of variance (ANOVA) was used for statistical analysis of log-transformed ELISA values (Ott 1977) of 95 brood year fall chinook salmon from Willard National Fish Hatchery (NFH) (Ponds 42, 43, 44, and 47).

Prophylactic Treatments

Prophylactic aquamycin treatments for BKD in spring chinook salmon juveniles were conducted under Investigational New Animal Drug (INAD) protocols. Formalin treatments on adult summer steelhead at Minthorn Ponds, adult fall chinook salmon at Three Mile Dam Adult Facility, and adult spring chinook salmon at South Fork Walla Walla Adult Facility were administered under prescriptions. Erythromycin via dorsal sinus injections at 10 mg per Kg fish body weight were prescribed and given to adult spring chinook salmon sorted for spawning at Three Mile Dam and South Fork Walla Walla adult facilities. Fish that were sorted by early July received a second injection in late July. Fish arriving after early July received only one injection.

Broodstock Monitoring

Adult fall chinook salmon for the 96 brood year program at Umatilla Hatchery were sampled at Priest Rapids on November 6, 12, and 13, 1996. Additionally, adult fall chinook salmon for the 96 brood year program at Umatilla Hatchery, Bonneville Hatchery, and Willard NFH were sampled at Three Mile Dam Adult Facility on November 1, 5, 8, 11, 15, 19, 22, and 26, 1996. Adult spring chinook salmon for the 97 brood year program at Umatilla Hatchery and Little White Salmon NFH were sampled at South Fork Walla Walla Adult Facility on August 12, 19, 26, and September 2 and 9, 1997. Adult summer steelhead for the 97 brood year program at Umatilla Hatchery were sampled at Minthorn Pond, as they have been since the steelhead program began. Midway through the steelhead spawning season, however, viral milt sampling and kidney sampling from spawned adults for Rs antigen were eliminated from the program because results were negative or values were so low that additional samples were not deemed useful.

RESULTS

Juvenile Monthly Monitoring

Necropsies

External parasites were not detected in wet mounts of gills or body scrapings from a total of 58 moribund/fresh-dead and 113 grab-sampled healthy fish examined by microscopy (these totals represent only a portion of the fish examined because not all were looked at for parasites). Occasional gill aneurysms, areas of hyperplastic filaments, and motile bacteria were observed on moribund/fresh-dead and grab-sampled fish. Gill cultures from moribund/fresh-dead and grab-sampled fish produced yellow pigmented colonies from 2/11 (20.8%) of the steelhead, 5/24 (4.2%) of the fall chinook salmon, and 2/31 (6.5%) of the spring chinook salmon cultured (Appendix Tables A-4, A-5, and A-6). These yellow colonies were identified as *F. psychrophilum* from one of the steelhead and one of the fall chinook salmon (Appendix Tables A-4 and A-5). Other yellow colonies from gill cultures could have been CWD bacteria, but they were not tested. *Flavobacterium psychrophilum* was not isolated from the gills of 31 spring chinook salmon cultured. Kidney smears cultured on TYE agar revealed the presence of systemic *F. psychrophilum* in 5/25 (20%) of the steelhead and 2/41 (4.9%) of the fall chinook salmon cultured (Appendix Tables A-4 and A-5). This bacterium was not isolated from the kidneys of any of the 52 spring chinook salmon cultured. Blood smears from 130 grab-sampled and 28 moribund/fresh-dead juvenile chinook salmon were examined during monthly monitoring and all were negative for cytoplasmic inclusions typical of erythrocytic inclusion body syndrome (EIBS). Anemia and pale gills, the typical signs associated with this infection, were not observed.

Assays for *Renibacterium salmoninarum* by the ELISA and DFAT

Nineteen moribund/fresh-dead and 45 grab-sampled 96 brood year Umatilla summer steelhead were tested by the ELISA for Rs during eight months of monthly monitoring (Appendix Table A-7). Kidney tissue from these fish was homogenized at a 1:7 or 1:15 weight:volume dilution. The mean optical density (OD) reading for the 19 moribund/fresh-dead steelhead was 0.021 and the range was 0.003-0.079. The mean for the 45 grab-sampled steelhead was 0.015 and the range was 0.005-0.079. Seven moribund/fresh-dead and five grab-sampled steelhead were examined by the direct fluorescent antibody test (DFAT) in the August and September monthly examinations because of small fish size (there was not sufficient kidney tissue to provide a sample large enough for ELISA processing). All fish were negative for the presence of Rs by DFAT (Appendix Table A-7).

Forty-two moribund/fresh-dead and 60 grab-sampled 95 brood year Priest Rapids fall chinook salmon, programmed as yearlings, were also tested for Rs by ELISA from August 1996 through January 1997 (Appendix Table A-8). Kidney tissues from these fish were homogenized at a 1:7 or 1:15 weight:volume dilution. The mean OD reading for the 42 moribund/fresh-dead fall chinook salmon was 0.063 and the range was 0.000-0.508. Thirty-five of these fish were at or below 0.093. Four moribund/fresh-dead fish exhibited very low positive OD values from 0.106 to 0.131, while the remaining three fish had higher Rs positive values of 0.231, 0.303, and 0.508. The mean OD reading for the 60 grab-sampled fall chinook salmon was 0.073 and the range was 0.005-0.238. Forty-five of these fish were at or below 0.085 OD units. Thirteen grab-sampled fish ranged from 0.108 to 0.198, while the two remaining fish showed OD readings of 0.211 and 0.238.

Forty-two moribund/fresh-dead and 55 grab-sampled 95 brood year Carson spring chinook salmon were tested by the ELISA for the presence of the Rs antigen from July-October 1996 (Appendix Table A-9). The mean OD reading for the moribund/fresh-dead fish was 0.018 and the range was 0.000-0.061. The mean OD reading for the grab-sampled fish was 0.018 and the range was 0.004-0.076. Also, ten moribund/fresh-dead and 15 grab-sampled fish from raceway O5A were examined by the DFAT for the

presence of the Rs antigen in April-June of 1996. All DFAT results were negative (Appendix Table A-9).

Juvenile Preliberation Monitoring

Necropsies

External parasites were not detected in wet mounts of gills or body scrapings examined by microscopy from one moribund/fresh-dead and 27 grab-sampled fish from all stocks and species at Umatilla Hatchery and yearling fall chinook salmon at Willard NFH. Gill condition was generally normal by gross examination, but there were some cases of gill aneurysms, stunted filaments, hemorrhaged filament tips, and gas bubbles in gill capillaries. Infectious hematopoietic necrosis virus (IHNV) and other culturable viruses were not detected by cell culture assays. One-hundred ninety blood smears from chinook salmon stocks at Umatilla Hatchery were negative for EIBS inclusions. At Willard NFH, 6/59 (10.2%) of the 95 brood year fall chinook salmon yearlings had typical EIBS inclusions ranging from one per microscope field to as high as five to seven per field. Hematocrits were not read. Notable increased loss due to CWD was evident on the day of preliberation at Willard NFH, with losses as high as 25% per month in one of four ponds destined for the Umatilla River.

Three grab-sampled 95 brood year spring chinook salmon yearlings from each of the two ponds at Imeques were negative for EIBS and for external parasites in body scrapings and gill wet mounts on March 13, 1998. *Flavobacterium psychrophilum* was detected in 4/10 (40%) of fresh-dead fish and *Yersinia ruckeri*, the agent of enteric redmouth disease (ERM), was detected in 1/10 (10%) of the fresh-dead fish. All fish at Imeques were reared at Umatilla Hatchery.

One pond of Priest Rapids 95 brood year fall chinook salmon yearlings reared at Umatilla Hatchery was also at Imeques. Five grab-sampled and five fresh-dead fish were examined on March 13, 1997. The five grab-sampled fish were negative for EIBS inclusions and external parasites. A moderate level (16 colonies) of *F. psychrophilum* was isolated from the kidney smear of one of five fresh-dead fish cultured on agar medium.

Also on March 13, 1997, a preliberation examination was conducted at the Thornhollow acclimation site on two ponds of 95 brood year fall chinook salmon yearlings from Umatilla Hatchery. Five grab-sampled fish per pond were negative for EIBS inclusions and the three fish examined per pond for external parasites were negative. *Flavobacterium psychrophilum* was detected at low levels (<seven colonies/kidney smear) in 4/10 (40%) of the fresh-dead fish. Tail erosion and some external fungus was seen on 6/10 (60%) of these fish.

Assays for *Renibacterium salmoninarum* by the ELISA and DFAT

All 60 values obtained from the 96 brood year Umatilla summer steelhead in raceways M8A and M8C were 0.049 OD units or less (Appendix Table A-10). Of the 30 grab-sampled fish from raceway M8B, 29 were 0.074 OD units or less and one had a low level positive value of 0.238. These results are consistent with values of previous years.

One-hundred fifty total 95 brood year fall chinook salmon yearlings were sampled from one Oregon series (O3A and B) and one Michigan series (M1A, B, and C) of raceways (Appendix Table A-

11). Of the 90 sampled from the Michigan raceways, six ranged from 0.224 to 0.385, and the remaining 84 were 0.197 OD units or less. Of the 60 sampled from the Oregon raceways, one had a value of 0.427, six ranged from 0.201 to 0.264, and the remaining 53 were 0.195 OD units or less. Statistical analysis indicated that the ELISA OD values for the Oregon raceways were higher than Michigan raceways ($P < 0.05$).

Sixty total Willard NFH 95 brood year fall chinook salmon were sampled from four ponds (42, 43, 46, and 47) prior to their transfer to the Umatilla basin (Appendix Table A-12). Two of sixty were in the moderate range at 0.407 and 0.562 while three of sixty were in the low range from 0.221-0.270. The remaining fifty-five were at or below 0.195 OD units. No statistical differences were found ($P < 0.05$) between these four raceways using one-way analysis of variance (ANOVA).

Ninety total 96 brood year Priest Rapids fall chinook salmon subyearlings were sampled from the third-pass raceway of three Michigan series (M1C, M2C, and M4C) of raceways (Appendix Table A-13). Only the third-pass raceways were sampled because several raceways had been combined, so fish had been reared together and were thus similar. One of ninety had a value of 0.113, and the remaining 89 were 0.069 OD units or less. There was no justification for statistical analysis because the values from the three raceways were similar, and there was no indication of Rs infection at preliberation.

One-hundred twenty total Carson 95 brood year spring chinook salmon yearlings were sampled from two Oregon series (O4A and B, and O5A and B) of raceways (Appendix Table A-14). The ELISA range of values was 0.008-0.323. Of 120 fish sampled, one was 0.323, two were 0.103-0.144, and the remaining 117 (97.6%) were at 0.086 OD units or less. No justification for statistical analysis was evident from the values obtained because the raceways were similar with the exception of the single low-level positive fish in O5A. There was no indication of significant Rs infection in this population.

At the Imeques acclimation facility, five moribund/fresh-dead 95 brood year spring chinook salmon smolts from each of two ponds (P1 and P2) had values of 0.037 OD units or less (Appendix Table A-15). Of the ten total grab-sampled fish, one was 0.107, and the remaining nine were at or below 0.042 OD units. Pond 4 contained 95 brood year fall chinook salmon smolts reared at Umatilla Hatchery. Five moribund/fresh-dead fish had ELISA values of 0.122 OD units or less, and five grab-sampled fish ranged from 0.080-0.191 (Appendix Table A-16).

At Thornhollow on March 13, 1997, ten grab-sampled and ten moribund/fresh-dead 95 brood year fall chinook salmon smolts, reared at Umatilla Hatchery, were examined. One of ten grab-sampled fish was 0.229 OD units while the remaining nine grab-sampled and ten moribund/fresh-dead had ELISA values of 0.193 OD units or less (Appendix Table A-17).

Prophylactic Treatments

Oral erythromycin (aquamycin) was administered twice under INAD protocols to the 95 brood year spring chinook salmon, programmed as yearlings, in two 28-day therapeutic regimens at a target dosage of 100 mg/Kg. The first treatment was started on May 29, 1996 and ended on June 25, 1996. No adverse reactions were observed. The second feeding started on December 6, 1996 and ended on January 2, 1997. Hatchery personnel reported that adverse reactions occurred three days after the start of this treatment. Feed consumption was poor. Signs of toxicity, both lethal and non-lethal, were documented on day one and three of toxicity testing. Internal hemorrhaging, yellow ascites fluid, and adhesions of the

air bladder and posterior kidney were observed about three days after aquamycin treatments began and continued throughout the treatment.

Broodstock Monitoring

The kidneys of 28 spawned Umatilla River summer steelhead (Appendix Table A-18) were sampled and analyzed for Rs antigen by the ELISA. Twenty-four spawned adults had OD values at or below 0.094, three ranged from 0.105-0.187, and one had a clinical reading of 1.226. No abnormal signs were observed upon excising the kidney sample from the clinically infected female. Five adult mortalities had ELISA values of 0.101 OD units or less. All fish sampled were negative for IHNV and other culturable viruses (Appendix Table A-20).

Sixty total fall chinook salmon spawned at Priest Rapids for Umatilla Hatchery 96 brood year production had ELISA values of 0.025 or less (Appendix Table A-21). One-hundred total females sampled for IHNV and other culturable viruses were negative (Appendix Table A-22), and sixty total females sampled for EIBS were negative for inclusions (Appendix Table A-23).

Up to twenty female subsamples of fall chinook salmon spawned at Three Mile Dam Adult Facility were collected on each of eight spawning dates. Of the total 139 females sampled, 137 were 0.087 OD units or less by ELISA, one was 0.326, and one had a clinical value of 2.297 (Appendix Table A-24). Gross observations indicated that the spleen of the clinically infected female was mottled and gray. Twenty-eight adult mortalities had ELISA values of 0.084 OD units or less (Appendix Table A-25). One-hundred thirty-nine total females sampled for IHNV and other culturable viruses (Appendix Table A-26) and EIBS (Appendix Table A-27) were negative. Adult pre-spawning mortalities exhibited a high prevalence of *Aeromonas salmonicida*, the bacterial agent of furunculosis. Of 28 mortalities examined, 16/28 (57.1%) kidneys cultured on agar medium showed systemic *A. salmonicida* infections.

Spring chinook salmon, transferred from Three Mile Dam Adult Facility and spawned at South Fork Walla Walla Adult Facility, produced eggs for the Umatilla Hatchery and Little White Salmon NFH 97 brood year. Of the 155 spawned fish sampled, three ranged from 0.111-0.139 ELISA OD values, and the remaining 152 were 0.098 OD units or less (Appendix Table A-28). Forty-nine of 54 adult mortalities had OD values less than or equal to 0.096, three ranged from 0.144-0.170, one was 0.240, and one was 0.434 (Appendix Table A-29). One-hundred ten spawned females sampled for IHNV and other culturable viruses were negative (Appendix Table A-30). Adult mortalities exhibited a low prevalence of *Carnobacterium piscicola* bacterium, the agent of pseudokidney disease. Of 54 mortalities examined, 3/54 (5.6%) kidneys cultured on agar medium showed systemic *C. piscicola* infections. *Yersinia ruckeri* was detected in 1/54 (1.9%) mortalities.

Using coded-wire tag recovery data from Umatilla River spring chinook salmon spawned at South Fork Walla Walla Adult Facility, it was possible to retrace the location and rearing strategy of 144 fish, thus allowing for comparisons of Rs levels (Appendix Table A-31). Ninety-eight of the 144 fish were reared at Bonneville Hatchery. One was 0.139 by ELISA, and the remaining 97 were 0.098 OD units or less. Twenty-one of the 144 fish were reared in Oregon raceways at Umatilla Hatchery and showed a range of 0.013-0.111 OD units. Fifteen of the 144 fish were reared in Michigan raceways at Umatilla Hatchery with values of 0.042 or less. Ten of 144 were of unknown origin and exhibited values of 0.050 OD units or less. Coded-wire tag data was also available for ten adult mortalities. Four of ten were reared at Bonneville Hatchery with an ELISA OD value of 0.055 or less. Another four were from Umatilla Hatchery and were 0.161 OD units or less, and the remaining two were of unknown origin at 0.096 and 0.434 OD units (Appendix Table A-32).

Fifteen carcasses of adult spring chinook salmon were sampled at the Umatilla River between June 26 and September 23, 1997. According to coded-wire tag data, nine of fifteen fish had been reared at Bonneville Hatchery and had ELISA values ranging from 0.036-1.291 OD units. Six of these nine had values at or below 0.076, one was 0.237, one was 0.456, and one had a clinical value of 1.291 (Appendix Table A-33). The remaining six of fifteen were from unknown origin. Four of these six were 0.086 OD units or less, one was 0.119, and one had a clinical value of 2.956. Carcasses from fish reared as juveniles at Umatilla Hatchery were not available for sampling.

DISCUSSION

For six years, fish pathology personnel have systematically documented and evaluated infectious disease-causing agents at Umatilla Hatchery. A consistent lack of ectoparasites and viral agents has been observed in fish at this hatchery, where juveniles are reared on well water. These results clearly support the use of a pathogen-free water source as a primary disease prevention strategy. Other disease prevention strategies are thought to contribute to the lack of parasites and disease agents in fish at Umatilla Hatchery. Bird netting minimizes the introduction of avian feces into the raceways. Fecal contamination from piscivorous birds can be a source of life-stages of some fish parasites and probably the columnaris bacterium. Also, the practice of water-hardening all eggs used for Umatilla Hatchery production in iodophor is believed to have measurably reduced the potential for vertical transmission of IHNV, *F. psychrophilum*, and likely certain other pathogens.

Bacterial infections in juveniles, with associated losses caused by either *F. psychrophilum* or Rs, have occurred during all previous report periods except 1993. Losses to CWD were reported in the 1992 and 1996 annual reports, and BKD losses were documented in the 1994, 1995, and 1996 annual reports. During this 1997 report period, however, no increased loss examinations were necessary. Neither clinical BKD nor CWD were detected during monthly or preliberation monitoring.

Results from monthly monitoring of Umatilla summer steelhead and Priest Rapids fall chinook salmon juveniles, however, reveal that there is a threat for CWD outbreaks to occur. For both of these stocks, *F. psychrophilum* was occasionally isolated, usually at low and moderate levels. This bacterium was detected at high levels in one juvenile fall chinook salmon mortality in August of 1996. The strategy of rearing fish in Michigan raceways without baffles was employed following severe CWD outbreaks in 94 brood year Priest Rapids fall chinook salmon (Groberg et al. 1998). The absence of baffles has probably helped to reduce stress, a catalyst for outbreaks. The lack of baffles also eliminated a potential source for dorsal abrasions, and consequent invasion by the CWD bacterium, occurring when the fish moved between compartments created by the baffles.

A high prevalence (57.1%) of *A. salmonicida* was detected in pre-spawning mortality of fall chinook salmon adults in the first year of operation at the Three Mile Dam Adult Facility. Prophylactic injections of oxytetracycline (OTC) should be implemented in future years to reduce the infection rate and hopefully the pre-spawning mortality. Prophylaxis should be given as an intraperitoneal injection of OTC at a dosage of 10 mg per Kg of fish body weight. This injection should be administered at the time the fish are sorted into the holding ponds. A second injection should be given 2-3 weeks before spawning. Evaluation of the effectiveness of this protocol should be made from necropsies of pre-spawning mortalities in future years. The need for adjustments to the prophylaxis, such as using a dosage of 20 mg per Kg, can then be assessed and made.

Though monthly monitoring for Rs antigen did not reveal any high levels among the 95 brood year Carson spring chinook salmon juveniles up to the time of liberation, there were three fish detected with low or moderate levels of Rs antigen at preliberation. A review of the status of Rs antigen in the Carson broodstock providing the 95 brood year eggs, which were spawned at Lyons Ferry Hatchery, provides an explanation for the paucity of Rs infection in the 95 brood year juveniles (Groberg et al. 1996). Of 32 females spawned and sampled for Umatilla Hatchery production on September 6, 1995, one had a clinical level of Rs antigen (1.584 OD units), but the other 31 females were in the negative or very low infection range (0.017-0.085 OD units). While these 32 females represent a subsample of the total population spawned for Umatilla Hatchery production, the fact that 97% of the subsampled females were either not infected or infected at negligible levels is consistent with the data collected on their progeny. The Carson adults spawned at Lyons Ferry and subsampled by ODFW Fish Pathology personnel in 1994 for 94 brood year production also showed low ELISA Rs antigen levels (Groberg et al. 1996).

The results of a similar analysis for Rs among Priest Rapids 95 brood year fall chinook salmon yearlings and their parental stock are ambiguous. Twenty females from the parental population were sampled on each of the four spawning days at Priest Rapids for Umatilla Hatchery production in 1995. The ELISA OD range among these 80 females was 0.000-0.029 OD units, with the highest value being just above the negative level. This is not a profile of a maternal population from which one would expect to see Rs infection in the progeny. Data from both monthly and preliberation Rs monitoring of the progeny, however, do show some fish with low and moderate levels of infection (Appendix Tables A-8 and A-11). Since Umatilla Hatchery uses well water that is unlikely to be contaminated with the Rs bacterium, one can conclude that a few females with infection levels higher than those fish in the subsample were present in the maternal population. The need to sample and assay every maternal parent in order to prevent such confusion of causal factors is clearly evident.

Re-examination of Rs results from the 94 Priest Rapids fall chinook salmon adults and juveniles reared at Umatilla Hatchery revealed ambiguity similar to the 95 brood year of the same stock. Since clinical infection of juvenile sockeye salmon from maternal parents with ELISA values in the 0.200-0.400 range has been observed (Keith Johnson personal communication), it appears that this may be mimicked to some degree in the Priest Rapids fall chinook salmon. The statistical results obtained with the 95 brood year Priest Rapids juveniles sampled at preliberation are of further interest. A t-test analysis indicated that the fish from Oregon raceways had higher ELISA values than those sampled from Michigan raceways. Scrutiny of the raw data (Appendix Table A-11), however, tends to make one highly skeptical of the conclusion that the statistical difference between the Michigan and Oregon raceway groups is biologically significant.

A considerable body of data, coupled with experience, regarding the Rs antigen supports the practice of either culling eggs from high-level BKD females or segregating eggs obtained from negative and low-level BKD females so that the progeny are hatched and reared separately from those that may eventually show high Rs levels and clinical BKD (Pascho et al. 1991, Tony Amandi and Doug Munson personal communication). These methods, based on the proven mechanism of vertical transmission by the BKD bacterium (Evelyn et al. 1986), are designed to reduce the impact of BKD on the subsequent generation of progeny. It is becoming an established fish culture practice to assay 100% of spring chinook salmon female broodstock for Rs antigen in order to facilitate a culling or segregation-based incubation and rearing strategy. Every effort should be made toward employing these strategies for artificial propagation programs of Umatilla Hatchery and basin spring chinook salmon.

This is the second consecutive report in which Rs antigen data is presented from adults reared as juveniles at Umatilla and Bonneville hatcheries, which includes data from spawned adults, pre-spawning mortality, and carcasses sampled in the Umatilla River. Rs infection levels were negative or very low in

all but five of 169 adults assayed. Two Bonneville-reared Umatilla River carcasses were moderately infected, one Bonneville-reared Umatilla River carcass was clinically infected, one Umatilla River carcass of unknown rearing location was clinically infected, and one pre-spawning mortality at the South Fork Walla Walla Adult Facility of unknown rearing origin was moderately infected. Since four of the five moderately and clinically infected adults were carcasses sampled in the Umatilla River, the efficacy of erythromycin prophylaxis in reducing Rs infection among adults held for spawning versus those that do not receive prophylaxis and spawn naturally is evident. Overall, the BKD incidence and severity was very low, and there was no indication of any differences between Bonneville and Umatilla hatchery-reared juveniles. These adult data are consistent with data collected and previously reported on jacks of the same populations (Groberg et al. 1996). There is not sufficient data to make comparisons of Rs infection levels between fish reared in Michigan and Oregon raceways at Umatilla Hatchery because so few adults, reared as juveniles at Umatilla Hatchery, have returned.

Analysis of the Rs data collected to date on adult spring chinook salmon returning to the Umatilla basin would support culling rather than segregation as a strategy for BKD management. Because so few females have had moderate, high, or clinical infection levels, only a small proportion of eggs would need to be culled. The small number of progeny that would potentially be derived from these eggs would not justify the water, space and effort required to rear them segregated. Annual monitoring of Rs in adults is needed to forecast and determine which BKD management strategy is most prudent for that particular brood year. In some recent years of spring chinook salmon juvenile-rearing for the Umatilla basin, BKD was of such severity that a segregation strategy may be required to accommodate production goals when these fish return as adults.

The fish health monitoring and evaluation program at Umatilla Hatchery has been an integral part of the fish culture program since its inception in the fall of 1991. Most fish health-related management recommendations have focused on the prevention of disease. When disease outbreaks have occurred, attention was given to making adjustments and recommendations that would attempt to prevent future episodes. Thus, the objective of the fish health program has been and will continue to be the promotion of good health among spawned fish and their progeny, reared and released in the Umatilla basin.

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Appendix Table A-1. Number of 96 brood year Umatilla summer steelhead juveniles sampled per raceway in Oregon raceway O2A and Michigan series M8 (A, B and C) during monthly monitoring.

Date sampled	O2A ¹	O2A ²	M8A ¹	M8A ²	M8B ¹	M8B ²	M8C ¹	M8C ²
08-96	3							
09-96	4	5						
10-96	2	5						
11-96			2		5		1	5
12-96			3		ND ³	5	1	5
01-97			1		2	5	1	5
02-97			ND ³		ND ³	5	ND ³	5
03-97			1	5				

¹ Moribund or fresh-dead fish.

² Normal, healthy appearing fish.

³ Indicates not done (ND) because no moribund or fresh-dead fish were available.

Appendix Table A-2. Number of 95 brood year Priest Rapids fall chinook salmon juveniles, released as yearlings, sampled per raceway in Oregon series O3 (A and B) and Michigan series M1 (A, B and C) during monthly monitoring.

Date sampled	O3A ¹	O3B ¹	O3B ²	M1A ¹	M1B ¹	M1C ¹	M1C ²
08-96	1	2	5	2	4	3	5
09-96	2	ND ³	5	1	4	ND ³	5
10-96	2	1	5	ND ³	1	ND ³	5
11-96	ND ³	1	5	ND ³	ND ³	1	5
12-96	1	1	5	1	ND ³	1	5
01-97	ND ³	4	5	ND ³	5	3	5

¹*Moribund or fresh-dead fish.*

²*Normal, healthy appearing fish.*

³*Indicates not done (ND) because no moribund or fresh-dead fish were available.*

Appendix Table A-3. Number of 95 brood year Carson spring chinook salmon juveniles, released as yearlings, sampled per raceway in Oregon series O4 (A and B) and O5 (A and B) during monthly monitoring.

Date sampled	O4A ¹	O4B ¹	O4B ²	O5A ¹	O5A ²	O5B ¹	O5B ²
04-96				2	5		
05-96				3	5		
06-96				5	5		
07-96				1		2	5
08-96	ND ³	4	5	ND ³		ND ³	5
09-96	ND ³	2	5	1		2	5
10-96	ND ³	3	5	2		2	5
11-96	3	ND ³	5	ND ³		1	5
12-96	5	5	5	5		5	5

¹*Moribund or fresh-dead fish.*

²*Normal, healthy appearing fish.*

³*Indicates not done (ND) because no moribund or fresh-dead fish were available*

Appendix Table A-4. Proportions and prevalences (%) of bacterial agents isolated from moribund or fresh-dead 96 brood year Umatilla summer steelhead during monthly juvenile fish health monitoring. Unless indicated otherwise, the prevalence was 0%.

Date sampled	Raceway	Systemic bacteria ¹		Gill bacteria ²
		<i>F. psychrophilum</i> ³	APS	
08-96	O2A	0/3	1/3 (33%)	ND ⁴
09-96	O2A	0/4	0/4	2/4 (50%)
10-96	O2A	0/2	0/2	0/2
11-96	M8A	1/2 (50%) ³	2/2 (100%)	ND ⁴
	M8B	1/5 (20%) ³	4/5 (80%)	ND ⁴
	M8C	1/1 (100%) ³	0/1	1/1 ³
12-96	M8A	2/2 (100%) ³	0/2	0/2
	M8B	ND ⁴	ND ⁴	ND ⁴
	M8C	0/1	0/1	0/1
01-97	M8A	0/1	0/1	ND ⁴
	M8B	0/2	0/2	ND ⁴
	M8C	0/1	1/1 (100%)	ND ⁴
02-97	M8A	ND ⁴	ND ⁴	ND ⁴
	M8B	ND ⁴	ND ⁴	ND ⁴
	M8C	ND ⁴	ND ⁴	ND ⁴
03-97	M8A	0/1	0/1	0/1

¹The only systemic bacteria isolated from kidney smear inocula were *Flavobacterium psychrophilum* and *aeromonad-pseudomonad* (APS) types.

²These were determined to be significant only if yellow pigmented colonies were the prevalent type on smears made from gill inocula.

³Two of these five isolates were tested by the rapid slide agglutination test using *F. psychrophilum* polyclonal rabbit antiserum.

⁴Indicates not done (ND) because no moribund or fresh-dead fish were available.

Appendix Table A-5. Proportions and prevalences (%) of bacterial agents isolated from moribund or fresh-dead 95 brood year Priest Rapids fall chinook salmon, released as yearlings, during monthly juvenile fish health monitoring. Unless indicated otherwise, the prevalence was 0%.

Date sampled	Raceway	Systemic bacteria ¹		Gill bacteria ²
		<i>F. psychrophilum</i>	APS	
08-96	O3A	1/1 (100%)	0/1	1/1 (100%)
	O3B	0/2	0/2	2/2 (100%)
	M1A	0/2	2/2 (100%)	0/2
	M1B	0/4	3/4 (75%)	ND ⁴
	M1C	0/3	1/3 (33%)	0/3
09-96	O3A	0/2	0/2	0/2
	M1A	0/1	0/1	1/1 (100%) ³
	M1B	0/4	3/4 (75%)	0/4
10-96	O3A	0/2	0/2	0/2
	O3B	0/1	0/1	0/1
	M1B	0/1	0/1	0/1
11-96	O3B	0/1	0/1	ND ⁴
	M1C	0/1	0/1	ND ⁴
12-96	O3A	0/1	0/1	ND ⁴
	O3B	0/1	1/1 (100%)	0/1
	M1A	0/1	0/1	0/1
	M1C	0/1	1/1 (100%)	1/1 (100%)
01-97	O3B	1/4 (25%)	2/4 (50%)	0/2
	M1B	0/5	0/5	ND ⁴
	M1C	0/3	1/3 (33%)	ND ⁴

¹The only systemic bacteria isolated from kidney smear inocula were *Flavobacterium psychrophilum* and *aeromonad-pseudomonad* (APS) types.

²These were determined to be significant only if yellow pigmented colonies were the prevalent type on smears made from gill inocula.

³Determined to be *F. psychrophilum* by the rapid slide agglutination test using *F. psychrophilum* polyclonal rabbit antiserum.

⁴Indicates not done (ND) because no moribund or fresh-dead fish were available.

Appendix Table A-6. Proportions and prevalences (%) of bacterial agents isolated from moribund or fresh-dead 95 brood year Carson spring chinook salmon, released as yearlings, during monthly juvenile fish health monitoring. Unless indicated otherwise, the prevalence was 0%.

Date sampled	Raceway	Systemic bacteria ¹		Gill bacteria ²
		<i>F. psychrophilum</i>	APS	
04-96	O5A	0/2	2/2 (100%)	0/2
05-96	O5A	0/3	1/3 (33%)	0/3
06-96	O5A	0/5	1/5 (20%)	1/4 (25%)
07-96	O5A	0/1	1/1 (100%)	0/1
	O5B	0/2	0/2	0/2
08-96	O4B	0/3	2/3 (66%)	0/1
09-96	O4B	0/2	0/2	0/2
	O5A	0/1	0/1	0/1
	O5B	0/2	0/2	0/2
10-96	O4B	0/3	0/3	0/3
	O5A	0/2	1/2 (50%)	1/2 (50%)
	O5B	0/2	1/2 (50%)	0/2
11-96	O4A	0/3	3/3 (100%)	0/3
	O5B	0/1	1/1 (100%)	ND ³
12-96	O4A	0/5	4/5 (80%)	ND ³
	O4B	0/5	1/5 (20%)	ND ³
	O5A	0/5	2/5 (40%)	0/3
	O5B	0/5	0/5	ND ³

¹The only systemic bacteria isolated from kidney smear inocula were aeromonad-pseudomonad (APS) types.

²These were determined to be significant only if yellow pigmented colonies were the prevalent type on smears made from gill inocula.

Appendix Table A-7. DFAT results and ELISA readings (OD₄₀₅) for *Renibacterium salmoninarum* of kidney samples¹ from 96 brood year Umatilla summer steelhead juveniles sampled during monthly monitoring from Oregon raceway O2A and Michigan series M8 (A, B and C).

Date sampled	ELISA OD ₄₀₅							
	O2A ²	O2A ³	M8A ²	M8A ³	M8B ²	M8B ³	M8C ²	M8C ³
08-96	0/3 ⁴							
09-96	0/4 ⁴	0/5 ⁴						
10-96	.006 .010	.006 .007 .007 .008 .008						
11-96			.017 .019		.003 .005 .009 .023 .023		.005	.006 .010 .010 .011 .023
12-96			.003 .005 .015			.010 .012 .014 .015 .021	.023	.009 .013 .014 .020 .040
01-97			.013		.069 .079	.014 .014 .018 .027 .031	.062	.015 .022 .027 .028 .079

¹ Kidney samples were homogenized in PBS-Tween 20 buffer at a 1:7 or 1:15 weight:volume dilution for ELISA.

² Moribund or fresh-dead fish.

³ Normal, healthy appearing fish.

⁴ Examined by the DFAT because of the small fish size.

Appendix Table A-7. Continued.

Date sampled	ELISA OD ₄₀₅							
	02A ²	02A ³	M8A ²	M8A ³	M8B ²	M8B ³	M8C ²	M8C ³
02-97						.005 .008 .008 .010 .011		.006 .006 .010 .010 .013
03-97			.010	.007 .007 .009 .014 .023				

Appendix Table A-8. DFAT results and ELISA readings (OD₄₀₅) for *Renibacterium salmoninarum* of kidney samples¹ from 95 brood year Priest Rapids fall chinook salmon juveniles, released as yearlings, sampled per raceway in one Oregon series O3 (A and B) and Michigan series M1 (A, B and C) during monthly monitoring.

Date sampled	O3A ²	O3B ²	O3B ³	M1A ²	M1B ²	M1C ²	M1C ³
08-96	.010	.013 .016	.005	.008	.019	.011	.007
			.008	.011	.021	.016	.009
			.009		.021	.035	.012
			.009		.068		.021
			.009				.045
09-96	.007 .231		.013	.030	.000		.014
			.023		.001		.018
			.028		.009		.028
			.035		.038		.031
			.047				.113
10-96	.022 .056	.021	.024		.018		.029
			.025				.029
			.026				.033
			.028				.034
			.043				.057
11-96		.081	.037			.040	.011
			.042				.030
			.047				.046
			.067				.046
			.075				.055
12-96	.131	.051	.108	.013		.112	.013
			.108	.060			.028
			.133				.030
			.172				.111
			.198				.168
01-97		.016 .026 .068 .117	.069		.023	.056	.108
			.076		.076	.093	.117
			.085		.090	.106	.148
			.144		.303		.170
			.211		.508		.238

¹ Kidney samples were homogenized in PBS-Tween 20 buffer at a 1:7 or 1:15 weight:volume dilution for ELISA.

² Moribund or fresh-dead fish.

³ Normal, healthy appearing fish.

Appendix Table A-9. DFAT results and ELISA readings (OD₄₀₅) for *Renibacterium salmoninarum* of kidney samples¹ from 95 brood year Carson spring chinook salmon juveniles, released as yearlings, sampled during monthly monitoring from Oregon series O4 (A and B) and O5 (A and B).

Date sampled	O4A ²	O4B ²	O4B ³	O5A ²	O5A ³	O5B ²	O5B ³
04-96				0/2 ⁴	0/5 ⁴		
05-96				0/3 ⁴	0/5 ⁴		
06-96				0/5 ⁴	0/5 ⁴		
07-96				.010		.000 .034	.004 .006 .006 .008 .008
08-96		.025 .029 .035	.011 .011 .012 .016 .028				.008 .010 .010 .013 .032
09-96		.004 .010	.006 .011 .011 .014 .031	.009		.009 .009	.007 .009 .009 .016 .019
10-96		.004 .022 .061	.015 .016 .017 .018 .018	.009 .066		.007 .021	.011 .015 .016 .022 .022

¹ Individual kidney samples were homogenized in PBS-Tween 20 buffer at a 1:7 or 1:15 weight:volume dilution for the ELISA.

² Moribund or fresh-dead fish.

³ Normal, healthy appearing fish.

⁴ Examined by the DFAT because of the small fish size.

Appendix Table A-9 Continued.

Date sampled	O4A ²	O4B ²	O4B ³	O5A ²	O5A ³	O5B ²	O5B ³
11-96	.014		.014			.017	.010
	.016		.019				.014
	.033		.021				.016
			.029				.024
			.041				.026
12-96	.002	.007	.007	.007		.014	.017
	.004	.010	.010	.013		.016	.041
	.010	.010	.011	.023		.018	.050
	.016	.014	.014	.027		.020	.062
	.034	.020	.020	.031		.027	.076

Appendix Table A-10. Preliberation ELISA readings (OD₄₀₅) for *Renibacterium salmoninarum* of kidney samples¹ from 30 Umatilla 96 brood year summer steelhead juveniles from each of three Michigan raceways M8 (A, B, and C). Means and ranges for each raceway are shown below the 30 individual sample readings. Fish in M8B and M8C were sampled on 03-06-97 at a mean body weight of 83.4 gms/fish. M8A was sampled on 04-09-97 at a mean body weight of 82.5 gms/fish.

Sample number	ELISA OD ₄₀₅		
	M8A	M8B	M8C
01	.007	.007	.006
02	.008	.009	.007
03	.008	.009	.007
04	.009	.011	.007
05	.010	.012	.008
06	.010	.012	.008
07	.011	.013	.012
08	.011	.013	.014
09	.012	.014	.014
10	.012	.014	.014
11	.013	.014	.015
12	.014	.015	.015
13	.014	.015	.016
14	.015	.015	.016
15	.015	.016	.017
16	.015	.016	.018
17	.016	.017	.018
18	.020	.017	.018
19	.020	.017	.020
20	.022	.018	.020
21	.022	.018	.022
22	.022	.020	.024
23	.023	.021	.024
24	.026	.026	.027
25	.027	.028	.028
26	.027	.030	.036
27	.027	.033	.037
28	.027	.043	.038
29	.029	.074	.041
30	.041	.283	.049
Mean	.018	.028	.020
Range	.007-.041	.007-.283	.006-.049

¹Kidney samples were homogenized in PBS-Tween 20 buffer at a 1:7 weight:volume dilution for ELISA.

Appendix Table A-11. Preliberation ELISA readings (OD₄₀₅) for *Renibacterium salmoninarum* of kidney samples¹ from 30 Priest Rapids 95 brood year fall chinook salmon juveniles per raceway, released as yearlings from Oregon series (O3A and B) and Michigan series (M1A, B, and C). Means and ranges for each raceway are shown below the 30 individual sample readings. All raceways were sampled on 02-06-97 at a mean body weight of 56.8 gms/fish.

Sample number	ELISA OD ₄₀₅				
	O3A	O3B	M1A	M1B	M1C
01	.060	.048	.032	.039	.036
02	.061	.056	.050	.048	.038
03	.064	.063	.059	.049	.045
04	.074	.075	.067	.055	.054
05	.076	.075	.069	.056	.055
06	.080	.084	.069	.060	.056
07	.083	.084	.081	.060	.057
08	.083	.088	.082	.062	.062
09	.085	.090	.089	.063	.068
10	.086	.096	.091	.070	.069
11	.087	.102	.093	.070	.071
12	.090	.102	.103	.072	.074
13	.090	.110	.103	.073	.076
14	.093	.116	.103	.077	.078
15	.093	.116	.104	.077	.078
16	.097	.117	.109	.079	.082
17	.098	.120	.117	.082	.084
18	.107	.124	.121	.090	.087
19	.112	.129	.140	.093	.089
20	.114	.132	.148	.094	.090
21	.114	.139	.157	.095	.100
22	.116	.148	.159	.097	.113
23	.116	.169	.159	.099	.117
24	.128	.173	.164	.104	.118
25	.146	.194	.171	.109	.135
26	.166	.201	.188	.126	.148
27	.181	.212	.197	.130	.159
28	.195	.228	.224	.136	.238
29	.229	.248	.224	.145	.239
30	.427	.264	.292	.166	.385
Mean	.118	.130	.126	.086	.103
Range	.060-.427	.048-.264	.032-.292	.039-.166	.036-.385

¹Kidney samples were homogenized in PBS-Tween 20 buffer at a 1:7 weight:volume dilution for ELISA.

Appendix Table A-12. Preliberation ELISA readings (OD₄₀₅) for *Renibacterium salmoninarum* of kidney samples¹ from 15 Willard 95 brood year fall chinook salmon juveniles per raceway, released as yearlings, from ponds 42, 43, 46, and 47. Means and ranges for each pond are shown below the 15 individual sample readings. Fish were sampled on 02-13-97 at a mean body weight of 32.4 gms/fish.

Sample number	ELISA OD ₄₀₅			
	Pond 42	Pond 43	Pond 46	Pond 47
01	.012	.023	.023	.023
02	.013	.024	.024	.024
03	.015	.041	.026	.029
04	.018	.052	.031	.033
05	.019	.061	.034	.034
06	.021	.067	.044	.034
07	.031	.067	.051	.035
08	.043	.068	.056	.042
09	.047	.071	.061	.049
10	.049	.079	.068	.054
11	.080	.156	.075	.058
12	.085	.160	.075	.081
13	.086	.171	.082	.084
14	.133	.221	.107	.195
15	.562	.407	.270	.237
Mean	.042	.111	.068	.067
Range	.012-.562	.023-.407	.023-.270	.023-.237

¹Kidney samples were homogenized in PBS-Tween 20 buffer at a 1:7 weight:volume dilution for ELISA.

Appendix Table A-13. Preliberation ELISA readings (OD₄₀₅) for *Renibacterium salmoninarum* of kidney samples¹ from 30 Priest Rapids 96 brood year fall chinook salmon juveniles per raceway, released as subyearlings, from Michigan series M1C, M2C, and M4C. Means and ranges for each raceway are shown below the individual sample readings. Fish were sampled on 05-07-97 at a mean body weight of 5.3 gms/fish.

Sample number	ELISA OD ₄₀₅		
	M1C	M2C	M4C
01	.005	.004	.008
02	.007	.007	.008
03	.010	.008	.009
04	.012	.010	.009
05	.012	.011	.010
06	.013	.012	.010
07	.016	.012	.010
08	.016	.013	.011
09	.016	.014	.013
10	.017	.015	.014
11	.018	.019	.015
12	.018	.019	.015
13	.018	.020	.016
14	.019	.021	.017
15	.019	.022	.017
16	.019	.024	.017
17	.020	.025	.019
18	.021	.027	.019
19	.022	.028	.019
20	.023	.029	.020
21	.024	.031	.021
22	.024	.033	.021
23	.030	.033	.022
24	.033	.038	.022
25	.037	.039	.024
26	.050	.043	.025
27	.054	.046	.027
28	.062	.051	.028
29	.065	.054	.036
30	.069	.113	.037
Mean	.026	.027	.018
Range	.005-.069	.004-.113	.008-.037

¹Kidney samples were homogenized in PBS-Tween 20 buffer at a 1:15 weight:volume dilution for ELISA.

Appendix Table A-14. Preliberation ELISA readings (OD₄₀₅) for *Renibacterium salmoninarum* of kidney samples¹ from 30 Carson 95 brood year spring chinook salmon juveniles per raceway from Oregon series O4 (A and B) and O5 (A and B). Means and ranges for each raceway are shown below the 30 individual sample readings. Fish were sampled on 01-14-97 at a mean body weight of 46.4 gms/fish.

Sample number	ELISA OD ₄₀₅			
	O4A	O4B	O5A	O5B
01	.008	.015	.014	.014
02	.009	.016	.015	.015
03	.012	.016	.016	.016
04	.013	.017	.016	.016
05	.013	.017	.017	.016
06	.013	.018	.018	.017
07	.016	.020	.020	.017
08	.016	.020	.020	.017
09	.016	.023	.020	.019
10	.017	.024	.020	.019
11	.017	.024	.021	.020
12	.017	.024	.021	.024
13	.018	.025	.025	.024
14	.018	.026	.025	.024
15	.019	.026	.026	.026
16	.019	.027	.032	.028
17	.021	.030	.033	.028
18	.022	.031	.035	.029
19	.023	.031	.036	.031
20	.023	.032	.038	.031
21	.023	.035	.039	.031
22	.024	.035	.042	.034
23	.026	.036	.042	.034
24	.028	.038	.043	.034
25	.029	.042	.053	.035
26	.030	.043	.054	.042
27	.031	.051	.067	.048
28	.044	.053	.069	.051
29	.059	.054	.072	.073
30	.103	.144	.323	.086
Mean	.024	.033	.042	.030
Range	.008-.103	.015-.144	.014-.323	.014-.086

¹ Kidney samples were homogenized in PBS-Tween 20 buffer at a 1:7 weight:volume dilution for ELISA.

Appendix Table A-15. Preliberation ELISA readings (OD₄₀₅) for *Renibacterium salmoninarum* of kidney samples¹ from five moribund/fresh-dead (Mt/Mb) and five grab-sampled (He) Carson 95 brood year spring chinook salmon juveniles, released as yearlings, from Imeques C-mem-ini-kem acclimation ponds. Fish were sampled on 03-13-97 and were reared at Umatilla Hatchery.

Pond 1		Pond 2	
Mt/Mb	He	Mt/Mb	He
.018	.012	.011	.016
.022	.024	.015	.018
.025	.039	.016	.018
.030	.042	.025	.019
.033	.107	.037	.031

¹ Kidney samples were homogenized in PBS-Tween 20 buffer at a 1:7 weight:volume dilution for ELISA.

Appendix Table A-16. Preliberation ELISA readings (OD₄₀₅) for *Renibacterium salmoninarum* of kidney samples¹ from five moribund/fresh-dead (Mt/Mb) and five grab-sampled (He) Priest Rapids 95 brood year fall chinook salmon juveniles, released as yearlings, from Imeques C-mem-ini-kem acclimation ponds. Fish were sampled on 03-13-97 and were reared at Umatilla Hatchery.

Pond 4	
Mt/Mb	He
.062	.080
.075	.100
.096	.116
.120	.126
.122	.191

¹ Kidney samples were homogenized in PBS-Tween 20 buffer at a 1:7 weight:volume dilution for ELISA.

Appendix Table A-17. Preliberation ELISA readings (OD₄₀₅) for *Renibacterium salmoninarum* of kidney samples¹ from five moribund/fresh-dead (Mt/Mb) and five grab-sampled (He) Priest Rapids 95 brood year fall chinook salmon juveniles, released as yearlings, from Thornhollow acclimation ponds. Fish were sampled on 03-13-97 and were reared at Umatilla Hatchery.

Pond 1		Pond 2	
Mt/Mb	He	Mt/Mb	He
.032	.068	.060	.068
.051	.093	.061	.105
.061	.103	.069	.105
.086	.134	.121	.113
.142	.229	.193	.143

¹ Kidney samples were homogenized in PBS-Tween 20 buffer at a 1:7 weight:volume dilution for ELISA.

Appendix Table A-18. ELISA readings (OD₄₀₅) for *Renibacterium salmoninarum* of kidney samples¹ from 28 Umatilla summer steelhead adults spawned in 1997 for Umatilla Hatchery 97 brood year production. Fish were sampled on 04-02-97, 04-17-97, and 04-24-97.

Sample number	ELISA OD ₄₀₅
01	.015
02	.024
03	.024
04	.030
05	.030
06	.033
07	.034
08	.036
09	.036
10	.041
11	.041
12	.041
13	.045
14	.047
15	.048
16	.049
17	.052
18	.056
19	.058
20	.066
21	.068
22	.082
23	.087
24	.094
25	.105
26	.155
27	.187
28	1.226

¹ Kidney samples were homogenized in PBS-Tween 20 buffer at a 1:3 weight:volume dilution for ELISA.

Appendix Table A-19. ELISA readings (OD₄₀₅) for *Renibacterium salmoninarum* of kidney samples¹ from five Umatilla summer steelhead adult mortalities in 1997.

Sample number	ELISA OD ₄₀₅
01	.031
02	.044
03	.047
04	.051
05	.101

¹ *Kidney samples were homogenized in PBS-Tween 20 buffer at a 1:3 weight:volume dilution for ELISA.*

Appendix Table A-20. Date and number of samples for culturable viruses from Umatilla summer steelhead spawned in 1997 for Umatilla 97 brood year production. Samples for culturable viruses were taken as individual ovarian fluid (OF) and milt (M) samples, and three-fish pooled pyloric caeca/kidney/spleen (PKS) samples. All samples were negative for infectious hematopoietic necrosis virus and other culturable viruses.

Date sampled	OF	M	PKS
04-02-97	8	8	6
04-17-97	3	3	2
04-24-97	3	3	2
05-08-97	5	5	4
05-14-97	3	ND ¹	2
05-21-97	5	ND ¹	4
05-28-97	3	ND ¹	2
06-04-97	2	ND ¹	2

¹ Indicates not done (ND).

Appendix Table A-21. ELISA readings (OD₄₀₅) for *Renibacterium salmoninarum* of 60 kidney samples¹ from Priest Rapids fall chinook salmon female adults spawned in 1996 for Umatilla Hatchery 96 brood year production.

Date sampled	ELISA OD ₄₀₅	Date sampled	ELISA OD ₄₀₅
11-06-96	.006	11-13-96	.005
	.008		.007
	.008		.007
	.009		.008
	.009		.009
	.011		.011
	.011		.011
	.011		.012
	.011		.013
	.013		.013
	.013		.013
	.013		.013
	.014		.014
	.014		.015
	.015		.015
	.015		.016
	.015		.016
	.016		.018
	.018		.019
	.025		.021
11-12-96	.007		
	.008		
	.008		
	.009		
	.009		
	.010		
	.011		
	.011		
	.012		
	.012		
	.013		
	.013		
	.013		
	.013		
	.014		
	.015		
	.016		
	.016		
	.019		
	.023		

¹ Kidney samples were homogenized in PBS-Tween 20 buffer at a 1:3 weight:volume dilution for ELISA.

Appendix Table A-22. Date and number of samples for culturable viruses from Priest Rapids fall chinook salmon spawned in 1996 for Umatilla Hatchery 96 brood year production. Samples for culturable viruses were taken as three-fish pooled¹ or individual² ovarian fluid (OF) and five-fish pooled pyloric caeca/kidney/spleen (PKS) samples. All samples were negative for infectious hematopoietic necrosis virus and other culturable viruses.

Date sampled	OF	PKS
11-06-96	20 ¹	12
11-12-96	20 ²	0
11-13-96	20 ²	0

Appendix Table A-23. Date and number of females sampled for erythrocytic inclusion body syndrome (EIBS) during spawning of Priest Rapids fall chinook salmon in 1996 for Umatilla Hatchery 96 brood year production. All were negative for EIBS inclusions.

Date sampled	Number of fish sampled
11-06-96	20
11-12-96	20
11-13-96	20

Appendix Table A-24. ELISA readings (OD₄₀₅) for *Renibacterium salmoninarum* of 139 kidney samples¹ from Umatilla fall chinook salmon female adults spawned in 1996 for Umatilla Hatchery 96 brood year production at Three Mile Dam Adult Facility.

Date sampled	ELISA OD ₄₀₅	Date sampled	ELISA OD ₄₀₅
11-01-96	.011	11-08-96	.009
	.012		.013
	.013		.015
	.013		.015
	.014		.016
	.017		.017
	.017		.018
	.021		.019
	.021		.019
	.022		.021
	.022		.021
	.022		.021
	.022		.022
	.023		.023
	.024		.023
	.030		.025
	.031		.025
	.031		.026
	.051		.034
	.087		.034
11-05-96	.009	11-11-96	.012
	.012		.013
	.012		.014
	.013		.015
	.014		.017
	.014		.017
	.015		.017
	.015		.019
	.015		.019
	.015		.020
	.016		.023
	.017		.023
	.020		.025
	.021		.025
	.022		.026
	.022		.026
	.026		.027
	.032		.030
	.033		.055
	.047		.060

¹ Kidney samples were homogenized in PBS-Tween 20 buffer at a 1:3 weight:volume dilution for ELISA.

Appendix Table A-24. Continued.

Date Sampled	ELISA OD ₄₀₅	Date Sampled	ELISA OD ₄₀₅
11-15-96	.017	11-22-96	.006
	.017		.009
	.018		.011
	.020		.012
	.020		.013
	.020		.016
	.021		.016
	.022		.016
	.023		.020
	.024		.021
	.025		.021
	.025		.023
	.026		.023
	.026		.023
	.027		.024
	.027		.027
	.028		
	.028		
	.029		
	.033		
11-19-96	.013	11-26-96	.022
	.014		.025
	.017		.051
	.018		
	.018		
	.021		
	.021		
	.021		
	.022		
	.022		
	.022		
	.023		
	.024		
	.025		
	.028		
	.030		
	.031		
	.050		
	.326		
	2.297		

Appendix Table A-25. ELISA readings (OD₄₀₅) for *Renibacterium salmoninarum* of kidney samples¹ from 28 Umatilla fall chinook salmon adult mortalities in 1996.

Sample number	ELISA OD ₄₀₅
01	.009
02	.012
03	.012
04	.013
05	.014
06	.015
07	.016
08	.017
09	.019
10	.020
11	.020
12	.021
13	.023
14	.023
15	.026
16	.027
17	.029
18	.029
19	.036
20	.038
21	.039
22	.040
23	.043
24	.045
25	.053
26	.063
27	.080
28	.084

¹ *Kidney samples were homogenized in PBS-Tween 20 buffer at a 1:3 weight:volume dilution for ELISA.*

Appendix Table A-26. Date and number of samples for culturable viruses from Umatilla fall chinook salmon spawned at Three Mile Dam Adult Facility in 1996 for Little White Salmon NFH 96 brood year production. Culturable viruses were sampled for as individual ovarian fluid (OF) and either four-fish¹ or five-fish² pooled pyloric caeca/kidney/spleen (PKS) samples. All samples were negative for infectious hematopoietic necrosis virus and other culturable viruses.

Date Sampled	OF	PKS
11-01-96	20	4 ²
11-05-96	20	5 ¹
11-08-96	20	5 ¹
11-11-96	20	0
11-15-96	20	0
11-19-96	20	0
11-22-96	16	0
11-26-96	3	0

Appendix Table A-27. Date and number of females sampled for erythrocytic inclusion body syndrome (EIBS) during spawning of Umatilla fall chinook salmon at Three Mile Dam Adult Facility in 1996 for Little White Salmon NFH 96 brood year production. All were negative for EIBS inclusions.

Date sampled	Number of fish sampled
11-01-96	20
11-05-96	20
11-08-96	20
11-11-96	20
11-15-96	20
11-19-96	20
11-22-96	16
11-26-96	3

Appendix Table A-28. ELISA readings (OD₄₀₅) for *Renibacterium salmoninarum* of 155 kidney samples¹ from Umatilla River spring chinook salmon male and female adults spawned in 1997 at South Fork Walla Walla Adult Facility for Umatilla Hatchery and Little White Salmon NFH 97 brood year production.

Date sampled	ELISA OD ₄₀₅	
	Female	Male
08-12-97	.035	
	.043	
08-19-97	.011	
	.013	
	.014	
	.014	
	.015	
	.015	
	.016	
	.017	
	.018	
	.021	
	.023	
	.023	
	.024	
	.025	
	.030	
	.070	
08-26-97	.094	
	.116	
	.015	.010
	.016	.011
	.017	.011
	.018	.012
	.018	.013
	.018	.013
	.018	.014
	.019	.015
	.019	.015
	.019	.016
	.022	.016
	.024	.017

¹Kidney samples were homogenized in PBS-Tween 20 buffer at a 1:3 weight:volume dilution for ELISA.
Appendix Table A-28. Continued.

Date Sampled	ELISA OD ₄₀₅	
	Female	Male
	.024	.018
	.027	.019
	.027	.019
	.028	.020
	.029	.020
	.029	.022
	.030	.023
	.030	.025
	.030	.028
	.034	.034
	.036	.037
	.038	.037
	.038	.080
	.046	.111
	.046	
	.048	
	.058	
09-02-97	.014	.010
	.015	.010
	.016	.011
	.017	.013
	.019	.017
	.019	.017
	.020	.018
	.020	.018
	.021	.019
	.021	.019
	.021	.019
	.022	.020
	.022	.020
	.023	.020
	.023	.020
	.024	.020
	.024	.022
	.025	.022
	.026	.024
	.031	.024

Appendix Table A-28. Continued.

ELISA		
OD ₄₀₅		
Date Sampled	Female	Male
09-09-97	.031	.025
	.032	.025
	.032	.028
	.033	.029
	.034	.032
	.035	.042
	.038	
	.042	
	.045	
	.050	
	.051	
	.064	
	.074	
	.079	
	.080	
	.098	
	.139	
	.013	.012
	.019	.016
	.024	.017
	.025	.017
	.026	.032
	.030	
	.030	
	.036	
	.042	
	.046	
	.047	
	.050	

Appendix Table A-29. ELISA readings (OD₄₀₅) for *Renibacterium salmoninarum* of kidney samples¹ from 54 Umatilla River spring chinook salmon adult mortalities in 1997 at South Fork Walla Walla Adult Facility for Umatilla Hatchery 97 brood year production.

Sample number	ELISA OD ₄₀₅	Sample number	ELISA OD ₄₀₅
01	.013	31	.034
02	.014	32	.035
03	.016	33	.035
04	.016	34	.035
05	.017	35	.036
06	.017	36	.037
07	.017	37	.038
08	.018	38	.040
09	.019	39	.045
10	.019	40	.046
11	.019	41	.053
12	.021	42	.055
13	.021	43	.060
14	.022	44	.061
15	.023	45	.062
16	.024	46	.066
17	.024	47	.085
18	.024	48	.086
19	.024	49	.096
20	.025	50	.144
21	.025	51	.161
22	.026	52	.170
23	.026	53	.240
24	.026	54	.434
25	.027		
26	.029		
27	.029		
28	.030		
29	.032		
30	.033		

¹ Kidney samples were homogenized in PBS-Tween 20 buffer at a 1:3 weight:volume dilution for ELISA.

Appendix Table A-30. Date and number of samples for culturable viruses from Umatilla River spring chinook salmon in 1997 at South Fork Walla Walla Adult Facility for Umatilla Hatchery and Little White Salmon NFH 97 brood year production. Samples for culturable viruses were taken as individual ovarian fluid (OF) and either two-fish¹ or four-fish² pooled pyloric caeca/kidney/spleen (PKS) samples. All samples were negative for infectious hematopoietic necrosis virus and other culturable viruses.

Date Sampled	OF	PKS
08-12-97	2	1 ¹
08-19-97	18	5 ²
08-26-97	24	10 ²
09-02-97	24	0
09-09-97	26	0

Appendix Table A-31. ELISA readings (OD₄₀₅) for *Renibacterium salmoninarum* of kidney samples¹ from 144 adult spring chinook salmon male and female adults spawned in 1997 at South Fork Walla Walla Adult Facility for Umatilla Hatchery and Little White Salmon NFH 97 brood year production. These fish were sampled between August 19 and September 9, 1997 and were identified by origin, either Bonneville Hatchery, Umatilla Hatchery or unknown, using coded wire tag recovery data. All fish were identified as 92 and 93 brood year fish. For Umatilla Hatchery, the type of rearing raceway, Oregon (OR) or Michigan (MI), is indicated.

<u>Bonneville Hatchery</u>	ELISA OD ₄₀₅		<u>Unknown</u>
	<u>Umatilla Hatchery</u> OR	MI	
.011	.013	.010	.005 ²
.011	.013	.011	.010
.012 ²	.017	.012 ²	.010
.012	.017	.015	.015
.012	.019	.018	.020
.013	.019	.018	.022
.013	.022	.018	.024
.013	.024	.019	.028
.014	.024	.020	.038
.014	.025	.022	.050
.015	.027	.022	
.015	.030	.023	
.015	.030	.032	
.016	.034	.038	
.016	.037	.042	
.016	.038		
.016	.045		
.016	.050		
.017	.058		
.017	.080		
.017	.111		
.017			
.017			
.017			
.018			
.018			
.018			
.018			
.019			
.019			
.019			
.019			

Appendix Table A-31. Continued.

<u>Bonneville Hatchery</u>	ELISA OD ₄₀₅ <u>Umatilla Hatchery</u> OR MI	<u>Unknown</u>
.019		
.019		
.019		
.019		
.020		
.020		
.020		
.020		
.020		
.020		
.020		
.021		
.021		
.021		
.022		
.022		
.023 ²		
.023		
.023		
.024		
.024		
.024		
.025		
.025		
.025		
.025		
.025		
.026		
.026		
.027		
.028		
.028		
.029		
.029		
.029		
.030		
.030		
.030		
.030		

Appendix Table A-31. Continued.

<u>Bonneville Hatchery</u>	ELISA OD ₄₀₅		<u>Unknown</u>
	<u>Umatilla Hatchery</u>		
	OR	MI	
.031			
.031			
.032			
.032			
.032			
.033 ²			
.033			
.034			
.034			
.035			
.036			
.036			
.037			
.042			
.042			
.046			
.046			
.046			
.047			
.048			
.064 ²			
.064			
.074			
.079			
.080			
.098			
.139			

¹Kidney samples were homogenized in PBS-Tween 20 buffer at a 1:3 weight:volume dilution for ELISA.

²These fish were killed, but not spawned.

Appendix Table A-32. ELISA readings (OD₄₀₅) for *Renibacterium salmoninarum* of kidney samples¹ from ten adult spring chinook salmon mortalities collected in 1997 at South Fork Walla Walla Adult Facility. These fish were sampled between August 26 and September 2, 1997 and were identified by origin, either Bonneville Hatchery, Umatilla Hatchery or unknown, using coded wire tag recovery data. All fish were identified as 92 and 93 brood year fish. For Umatilla Hatchery, the type of rearing raceway, Oregon (OR) or Michigan (MI), is indicated.

<u>Bonneville Hatchery</u>	ELISA OD ₄₀₅		<u>Unknown</u>
	<u>Umatilla Hatchery</u> OR	MI	
.024	.025	.038	.096
.026	.161	.046	.434
.053			
.055			

¹Kidney samples were homogenized in PBS-Tween 20 buffer at a 1:3 weight:volume dilution for ELISA.

Appendix Table A-33. ELISA readings (OD₄₀₅) for *Renibacterium salmoninarum* of kidney samples¹ from 15 carcasses of adult spring chinook salmon collected from the Umatilla River in 1997. These fish were sampled between June 26 and September 23, 1997 and were identified by origin, either Bonneville Hatchery or unknown, using coded wire tag recovery data. All fish were identified as 92 and 93 brood year fish. Samples were provided by fisheries personnel of the Confederated Tribes of the Umatilla Indian Reservation.

ELISA OD ₄₀₅	
<u>Bonneville Hatchery</u>	<u>Unknown</u>
<hr/>	<hr/>
.036	.024
.044	.043
.045	.070
.056	.086
.064	.119
.076	2.956
.237	
.456	
1.291	

¹Kidney samples were homogenized in PBS-Tween 20 buffer at a 1:3 weight:volume dilution for ELISA.